

The AMSAT[®] Journal

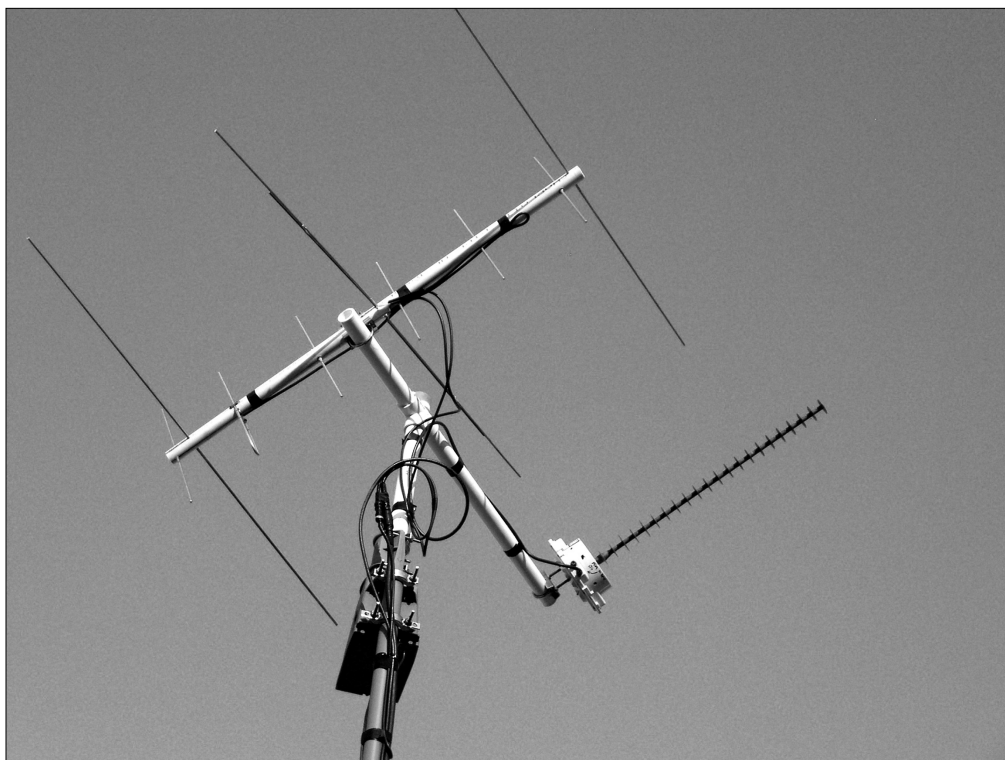


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Volume 32, Number 1

January/February 2009



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Bequest

A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA

AMSAT Announcements

Eastern VHF/UHF Conference

Registration is now open for the 35th Eastern VHF/UHF Conference on April 17-19, 2009 in Enfield, Ct. Papers for the Proceedings are due March 10, 2009. More info at: <http://www.newsvhf.com/vhfconf.html>

AMSAT-UK Colloquium

The AMSAT-UK Colloquium will be held July 24 - 26. Please see the detailed announcement on page 14.

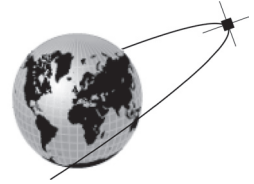
AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.





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Since I last wrote an Apogee View column, a number of interesting developments have occurred that I'd like to share with you. While it may appear that not much is 'happening', in fact there is some exciting activity taking place.

Near Term Engineering Task Force/ Engineering Developments

I announced during the 2008 Annual Meeting that an Engineering Task Force was being formed to evaluate a number of satellite proposals and to help AMSAT prioritize how we use our engineering resources. Under the leadership of Bill Ress, N6GHZ, this group has been meeting bi-weekly to review options and to evaluate how we might move forward on future satellite opportunities. Bill wrote an article in the November-December 2008 issue of *The AMSAT Journal* about the work of the task force and has promised to initiate a regular column in the Journal to bring our membership up to speed on their activities. In essence, Bill's Team is currently serving as AMSAT's Engineering Department leadership and has allowed AMSAT to benefit from a broad array of expertise to address AMSAT's engineering challenges. The team includes Tom Clark, K3IO; Lou McFadin, W5DID; Drew Glasbrenner, KO4MA; and Tony Monteiro, AA2TX.

Rather than steal Bill's 'thunder', I'll leave it to him to provide an update on the team's activities. I will point out however, that one major benefit of the Task Force is their willingness to help with the SuitSat-2 project. Bill, N6GHZ, and Task Force Member Tony Monteiro, AA2TX, are now fully engaged in the SuitSat-2 project, lending their considerable talents in the areas of transmitter development (N6GHZ) and SDX development (AA2TX). Tony is working with Jim Johns, KA0IQT, and Bill Reed, NX5R, on SDX. K3IO continues to serve as a consultant to the SuitSat-2 Team.

Under the leadership of ARISS Hardware Manager Lou McFadin, W5DID, and SuitSat-2 Systems Engineering Manager Gould Smith, WA4SXM, the SuitSat-2 team met in Phoenix, AZ the weekend of 21 FEB 09 to conduct a project review and demonstrate 'working modules'. This meeting allowed those individuals actively working on SuitSat-2 in Phoenix, California and the East Coast to get together to work out issues, enhance working relationships,

and settle on a project timeline for the remainder of the project. At the moment, SuitSat-2 is AMSAT's primary satellite project. Successful completion of this project is critical to the future of AMSAT. First, we have a guaranteed launch opportunity and a window for completion. Second, much of the technology being developed for SuitSat-2 has broader application potential to future AMSAT projects, including Eagle. For example, SuitSat-2 will feature an SDX (Software Defined Transponder) and this SDX will be the first one to be flown in space by AMSAT. Third, SuitSat-2 offers an opportunity to develop a 'modularization approach' to satellite design that will hopefully allow AMSAT to be more responsive to future launch opportunities. If we can indeed create a variety of modules that can be easily adapted to different launch opportunities and potential satellite configurations, AMSAT stands a much better chance of being able to quickly respond to short-term notice of a launch that meets our needs and is 'affordable'. See Gould's article in this issue.

ITAR

As noted in earlier "Apogee View" columns, AMSAT is coming to grips with ITAR (International Traffic in Arms Regulations) and how to work within current government regulations in such a way that we can continue our working relationships with other AMSAT organizations. Bill Ress, N6GHZ, wrote a paper on ITAR for the 2008 AMSAT Symposium Proceedings that outlined a suggested approach for dealing with this difficult issue. In this issue of *The AMSAT Journal*, Bill has also written an article on ITAR and export regulations that explains some of the issues that AMSAT is facing in working with our international partners.

We have retained Attorney Frank Schuchat of Schuchat, Herzog & Brennan, LLC of Denver, CO to help us go through a process that will 1) bring the US State Department up to speed on past AMSAT activities involving foreign nationals (such as our involvement with P3-D and P3-E), 2) create within AMSAT the appropriate materials and procedures needed to fully comply

continued on page 27 ...



Easy S-Band on the EasySats Michael Heim, KD0AR, kd0ar@sbcglobal.net

Many of you no doubt are operating the FM satellites, some with a minimum of equipment, such as a dual band HT and a small handheld Yagi and are having a lot of fun working across the country with a watt or two on the VHF bands. There are several birds in orbit that allows access on 145 MHz uplink and 435 MHz down. It's easy to get on these satellites. It takes no special equipment, except perhaps some specialized computer software, some of which is totally free, and maybe a simple small antenna, either store bought or can be built at a very low cost. If you have a dual band radio that covers 2 m and 70 cm, you have the bulk of what you need to get on. Many have discovered just how easy it is to operate the FM satellites. Now that you're active on the V/U modes, might I present in this paper an easy way to step up to adding 2401 MHz so that you can also enjoy when AO-51 is switched to mode V/S. It's easier than you might think. Let me describe my experiences from a newcomer's point of view.

In my local area, we had a company that had gone out of business that was in the business of supplying cable television over a microwave path directly to its subscribers. The cost of this service was quite low in comparison to the regular cable TV company that served my local area, so the business at

first took off. Homes that had the service had odd looking tiny antennas mounted on tripods on the roofs of their homes. This company was in business for a couple years, and in the process had accumulated many thousands of customers. Anyone could receive these signals, so long as the broadcast tower that the transmitter was located could be seen from the rooftop of the home that wanted the service.

About two years ago, the company went out of business, although, as they were quite popular in the area here. When they closed their doors, they left all of the receive equipment on the rooftops of all the homes that had the service. Many homes still have the antennas up, but on occasion, I have been seeing the antennas and mast mounted downconverters tossed on the curb with their trash. There are different varieties; some have the familiar BBQ dishes that you see in some of the Oscar 40 technical literature online, some have a strange looking Yagi that is directly attached to the down converter. These converters, usually in a sealed, aluminum white box converted 2500 MHz to about 222 MHz. The bandwidth is a couple hundred MHz, and there are actually two different bands that these operate at. For the sake of this paper, let's just refer to the 2500 – 2700 MHz band.

Although my experiences with these units didn't cost me a dime, I understand some areas of the country aren't this fortunate. I am seeing, however, the same units available on eBay for very inexpensive prices, so this paper should appeal to everyone who operates the FM satellites now. These may appear at hamfests across the country, as a lot of these units have been in use around the country.

Why Get on Mode S

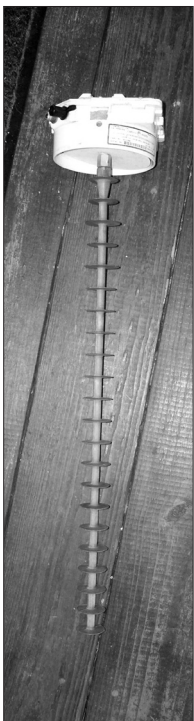
I can list a variety of reasons why it is a good idea to give this mode a try, but as enterprising amateurs, the number one reason why I'm betting you would like to try is because it gives you the opportunity to experiment with a new frequency. It is for this reason alone why some of the rig manufacturers have included 6 meters, 2 meters and 70 centimeters in some of their lower cost HF radios. They allow the purchaser the opportunity to experiment on new bands they would otherwise have to spend a large chunk of cash to try, and then

in the end, they may or may not choose to operate for whatever reason after they had spent the money. Many operators see getting on 2400 MHz as a large additional outlay of cash for a band they might just want to "try", only to decide that for one reason or another, they don't like the band. Allow me to list a couple of other reasons why it would be a good idea to at least TRY this new mode:

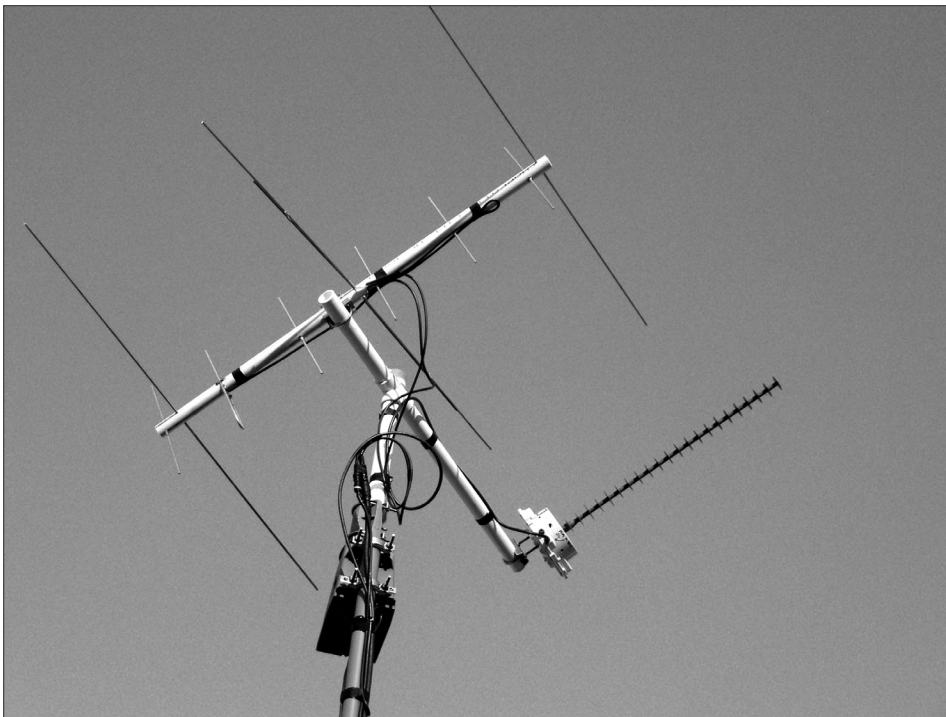
- It's "High Tech". 2400 MHz is a microwave band, and a very tiny percentage of hams have the capability to operate anything above 70 cm.
- The higher the frequency, the smaller the antennas become. This might appeal to deed restricted locations.
- The band is quieter than 2 m or 70 cm. This means it's possible to hear more with weaker signals, especially in urban areas.
- It presents new challenges. Doppler, for instance is roughly 5 times greater than on 2400 MHz than on 70 cm. This isn't an issue if you run computer control over your receiver.
- Most, if not all future satellites, especially the Phase 3 birds will almost certainly have a mode S downlink. So, why not gain some experience now? Any of the equipment presented here will be capable of modification to use on any of the Phase 3 birds once they're up.

Nice list of reasons to get on. There is a supplier of ready-made, ready to use equipment that will allow you to get on right out of the box, and that is one way to go. The prices are reasonable at about \$100 or less, as I recall. K5GNA is the supplier of this equipment; however his Web site is not active at the time of this writing. He sells modified units similar to what I'm going to tell you about in this article. His units have been modified somewhat more extensively than these that I'm going to describe.

The modifications that I am writing about in this paper are very simple, however you must have the capability of being able to receive 123 MHz. An easy test would be to take your HT or rig and see if it will accept this frequency. If it does, you're in business. If it does not, might I suggest a police scanner as a mode S receiver? It's a good idea to be able to hear yourself on your downlink



Downconverter ready for mounting to the mast.



S Band unit installed on the mast.

anyway, so the scanner idea might not be a bad suggestion.

Converting a Surplus Downconverter

A down converter is a device that converts one frequency to another frequency. It does this by combining the frequency you wish to hear with an internally generated oscillator and heterodyning the second to create a third frequency, the IF, which is within the receiving range of a radio that you already own. These converters (and EVERY one that I know of) convert 2500 to 222 MHz. To do this, an internal oscillator frequency can be calculated to be $2500 - 222 = 2278$ MHz. We can then calculate what the receive frequency that you would have to tune your receiver being fed signal from this device would be simply by taking the frequency you wish to receive, in the case of AO-51, that would be 2401.200 and subtracting that from the internal oscillator in the converter which is 2278. The receiver then would be tuned to 123.200, and you should be able to hear AO-51, right? Well yes, the math works, but there are filters in the converter that need to be “tuned” so you can receive down to 2400 MHz. There are three filters in the units that I use, which were manufactured by California Amplifier”. The first is a rather large filter that has the appearance of a copper “comb”. I simply removed this item from the unit. It is easy to remove, simply by removing the cover for the filter, unsoldering the two ends

of the copper filter, and bypassing a small resonator on the PC board. The cover and “comb” can be thrown away.

Some units do not have this comb shaped filter; however every one that I’ve seen has another filter on the PC board, etched into the board. This filter is easy to modify, by simply sticking some clear plastic packing tape over the filter. I found 4 or 5 layers to be just about right. This effectively reduces the frequency enough to be able to receive 2400 MHz. The “low side” filter will have to be cut out of the circuit, and that can be done with a hobby knife. All you have left to do is place the outer cover back on. The unit will now tune to 2400 MHz, and output that on 122 MHz.

There are complete instructions as to how to modify the California Amplifier units. There are two models which I have converted, the first is a little brick that uses the external antenna. The instructions can be found at: <http://www.qsl.net/g0ory/2.3g/31732/31732.html>. I did not change out the LO crystal on my unit, and it works FB on the satellite subband merely by retuning the front end. By the way, Adam’s crystal frequency calculations will also work with the converter I am currently using, the one with the integrated antenna.

The second unit, the 130099 is also very easy to convert. Andy, K0SM, of the Rochester VHF Group has come up with a very simple

mod for the 130016. The 130099 is identical to the 130016, except the ’16 has an N connector in place of the attached antenna. The electronics are the same. I followed his instructions to convert my ’99 using his instructions that can be found at: <http://www.rvhfg.org/articles/k0sm/basic%20mods.php>.

Because I followed this work exactly, I do not want to duplicate it here, nor do I claim to have created any original mods to these converters. Instead, I want to share with readers just how easy it is to use one of these units for AMSAT work.

Installation and Hookup

To mast mount the unit, you will need a bias tee on the radio side, and there are a couple ways to go about this. One, and the easiest way is to use a two-way TV splitter that has pass-thru on one of its ports. The converters all use 75 ohm RG-6 cable on the IF side with F connectors, so this is a natural to use. On the pass thru output connector, feed 15 – 20 volts thru an inductor into that port. The inductor can be a small air wound coil, with about 10 turns around a plastic drinking straw. The value isn’t critical. The radio will then be hooked to the “DC Block” port. You can take a piece of RG-6 and put an F connector on one end, and a BNC on the other. If you want to put a PL-259 or N connector on the radio end, use RG-59, as it has a copper braid outer conductor. Screw on BNC’s work FB with RG-6.

The other way is to make a bias tee. They’re not difficult. You need a small enclosure, which can be made of double sided PC board, or a small aluminum or plastic box. Mount 2 connectors on the box, say perhaps BNC female connectors. Install a feed-thru cap and ground lug for the DC power. On the feed-thru, insert a coil, similar to the one I described above (10 turns around a drinking straw). Place the other end on the converter side connector. It would also be a good idea to label the connectors – “CONVERTER” and “RADIO”. Now, place a 100 pf capacitor between the two RF connectors. You should now have a bias tee that is suitable for 122 – 123 MHz. This allows the DC power for the converter to travel up the coax line to the converter. This is how the converter was powered originally, and it works fine for our purpose also.

One other external item you might want to consider, and is something I haven’t done as yet, which I do plan on doing is to build a small 10 – 20 dB attenuator pad between the



radio and the bias tee. There are three good reasons for this, one is if the capacitor fails, instead of having 16 volts DC or more on the RF connector of your radio, it will reduce it to the point that it will most certainly be safe for the radio. Second it will prevent a converter burnout if you would happen to transmit into the converter. We have all blown preamps by doing this, I'm sure... I would use a 20 dB pad myself. That will only allow 1/100 the output power of the radio to reach the converter output should this happen. The last good reason is because there is a LOT of gain in these converters, most of which have over 30 dB of gain. When I hook mine up to my FT-817, I have a resting S-8 noise floor due to the gain in the converter. 20 dB will knock that down to an S-1 or so. The received signal quality will not suffer. In fact it may even enhance the readability of the bird.

The unit I have up on the mast right now has an 18 inch long Yagi attached directly to the downconverter. The unit is a complete AO-51 antenna as it is. Its linear polarized, which doesn't seem to be a big deal with AO-51. It works very well, giving me a totally full quieting signal from about 5-6 degrees above each horizon. There is a major fade as it flies by me that lasts only about 30 seconds or so. Online documentation says this antenna has 16 dB of gain.

If you have a unit that was meant to be used with an external antenna, this opens up some interesting antenna experimentation. There are many antenna articles online that describe various antennas used for satellite work, including helicals, dishes, etc. I have such a unit and it works nicely with a homebrew 14-turn helix. If you look on the Internet for an S band antenna, don't overlook articles that feature antennas to be used for wireless networking. Remember, channels 1 thru 6 of your wireless G router are in the 2400 MHz amateur band! There is a wealth of antenna articles on the internet for these devices, and they work FB for our satellite use also.

Mode S Operation

Now that you see how easy it is to get on 2400 MHz, what can you expect once you get the antenna up and working? Well, trees are a brick wall on these frequencies. I have trees that are close in to the south, so once the satellite gets behind the trees, I pretty much lose the downlink. If you have trees a short distance away, it's not bad. I have a tree line to the north that is about 200-300 feet away, and they don't seem to be as big of a problem as the ones that are directly south. I can get the bird down to about 3 degrees above the horizon to the north, and about 15 degrees or so above the horizon when it's south of me.

Signals are quite strong when the bird is in the clear. The signal to noise ratio is about 30 dB, according to my S meter on the radio. My noise floor is an S-8, and when someone is transmitting on the bird, the signal is about 20 over when the bird is at an elevation of about 30 degrees in the clear, dropping to S-9 when it's up about 5-6 degrees.

Doppler shift is more severe. AOS tune about 50 kHz above the center frequency, and it drifts down to about 50 kHz below the center frequency as it passes across the sky. This is much more noticeable than on UHF, which drifts 10 KHz above and below the center frequency.

On a side note, the drift is manageable. This is what I like about mode V/S. If I was on the L band (1269 MHz) uplink, I would have to tune two radios, as the L band uplink would be about three times worse than the UHF band. As it is on VHF, the uplink does not have to be tracked, as the Doppler is only about plus or minus 3 kHz, and the satellite receiver is wide enough for that amount of offset to be a problem.

Well, there you have it. I hope to see some newcomers on S-band. The bird is quiet, and although it's nice to be able to rag chew on AO-51, I would also like to be able to work VUCC on S Band as well.

References

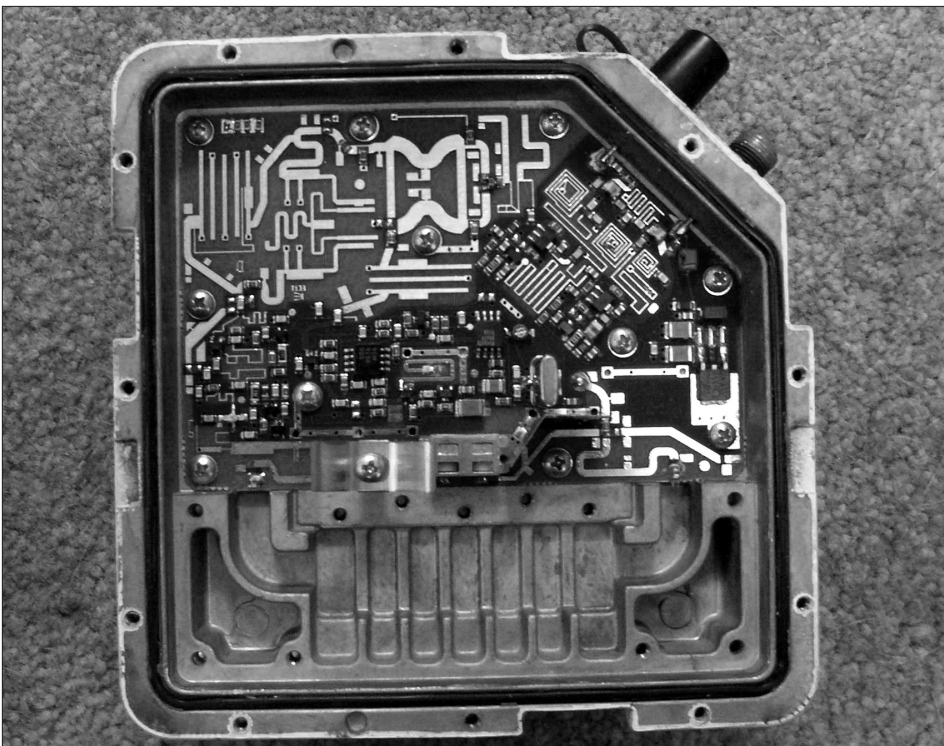
An Easy Way to Receive S-Band Using the Cal-Amp 130016, Rochester VHF Group Web site, <http://www.rvhfg.org/articles/k0sm/basic%20mods.php> by Andy Flowers, K0SM.

California Amplifier 31732 Downconverter, G0ORY personal Web site, <http://www.qsl.net/g0ory/2.3g/31732/31732.html> by Adam Moss, G0ORY.

About the Author

Michael Heim, KD0AR, (AMSAT # 36924) has been active in satellite operation for a brief period in the mid-80's, active on AO-10 and AO-13. He has recently moved to a location that has some antenna restrictions. Operating satellites is keeping him involved with Amateur Radio. He considers himself a newcomer, being active for only a couple of months on the LEO's. Mike is an Extra Class ham, and was first licensed in 1980. He also operates portable on the 10 GHz band.

Mike is the chief engineer for six radio stations in northwest Pennsylvania, working for Forever Broadcasting, and operates stations in the New Castle and Oil City / Franklin, PA markets. ☺



The internal view of the converter.

Where's the Launch? Getting Phase 3 Satellites into Orbit

by Lee McLamb, KU4OS, ku4os@amsat.org

Abstract

Several existing and potential future options for launching Phase 3 satellites will be explored. In addition, this paper addresses the constantly evolving business environment in which secondary payloads must find launches. To be successful AMSAT and all the supporting volunteers must adapt their philosophy with respect to how satellite projects are supported and managed.

In the past amateur satellite projects have frequently not had the benefit of full financial and volunteer support until a launch date was identified. When I've manned the AMSAT booth at various hamfests I have often heard people say that they'll start supporting a satellite project once the launch has been identified. Similar sentiments have also been expressed in electronic forums such as AMSAT-BB. While waiting until



Figure 1: Delta II Dual-Payload Attach Fitting.

the launch opportunity or date was set has worked in the past, it also created numerous problems and is no longer a viable option due to changes in the launch market. As a result AMSAT's Eagle project needs your support **now** if we are to be prepared to take advantage of launch opportunities once they are identified.

Today's Launch Vehicle Market

As experience with and confidence in today's modern rockets has grown, the length of time

it takes to plan and integrate space launch missions has shrunk. The result is lower price launches for the primary payloads. While this is an advantage in the commercial market it creates a great challenge for those who are looking for secondary payload opportunities as the time available to identify and respond to an opportunity is also diminished. One of the large contrasts between commercial satellite programs and traditional amateur satellite programs has been when the investment in significant development and construction starts.

Commercial satellites are typically in construction long before a contract for launch is ever signed. As the satellite progresses toward completion, at the appropriate point in the schedule a launcher is put on contract. For commercial launches the contract is signed typically only about twelve months before launch. Some launch providers, such as Lockheed Martin Commercial Launch Services (LMCLS), advertise a capability to launch as soon as four months after signing a contract.

The 2006 launch of Atlas V/Astra 1KR is a good example of the volatile and rapid changes that can now take place in the commercial launch market. Astra 1KR was initially contracted in April 2004 for launch on an Ariane V. Part of that contract required that Ariane V ECA conduct two successful qualification flights plus two successful commercial flights prior to Astra 1KR. Since Ariane couldn't meet that requirement by the needed launch date, the contract was given to ILS in February 2005 for launch on a Proton M rocket. To meet the contracted launch date, ILS swapped the Astra 1KR payload from Proton M to Atlas V in December 2005 and finally launched on April 20, 2006.

Because of these short time horizons the old amateur satellite program model of "wait for an identified launch" is simply no longer viable. Instead we need to follow the lead of the commercial programs and make the commitment to building our satellites up front so that we are prepared to use launch opportunities when they finally arise. Fortunately the development of standardized secondary payload adapters for both Ariane V and the Evolved Expendable Launch Vehicles (Delta IV and Atlas V) has also made this more feasible than in the past.

There are other benefits to getting an early

start as well. First, amateur satellites could often have benefited from additional time for more thorough testing so that problems can be found and fixed on the ground instead of being worked around once in orbit. Complete and detailed testing will greatly reduce the risk of failure after launch. Another benefit that also reduces the risk to our precious spacecraft is avoiding over-work and burn out by the volunteers doing the actual construction. Many of them have stories of sixty to eighty hour weeks being worked to meet certain critical dates. While their heroics are certainly appreciated, it is really an unfair burden to place on volunteers and creates too many opportunities for error due to fatigue or lack of time for review and verification.

TANSTAAFL

With apologies to Robert Heinlein [1] let me say right up front, There Ain't No Such

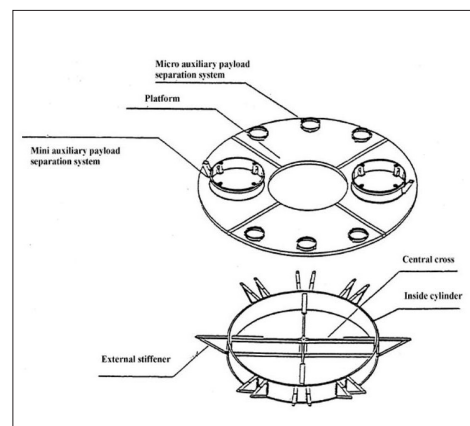


Figure 2: ASAP5 Mounting Locations for Both 'Mini'- and 'Micro'-sized Spacecraft

Thing As A Free Launch. The cost of paying for even a secondary launch opportunity is fairly daunting. As a result I'm frequently asked about getting another "free launch" like we had for earlier satellites. While AMSAT may not have directly paid a fee for an earlier launch, there are always some fairly substantial costs involved with adding a secondary payload to a mission due to the additional engineering and analysis involved. These costs get paid by someone. So while there's no "free" launch, there may be groups who would see the benefit in helping AMSAT's Eagle satellites get into orbit. One of the key aspects in gaining the support of outside groups is the perceived viability of the project. We must be able to demonstrate that we have both the technical and financial resources to see a project

Photo credit: Boeing

Drawing credit: Arianespace



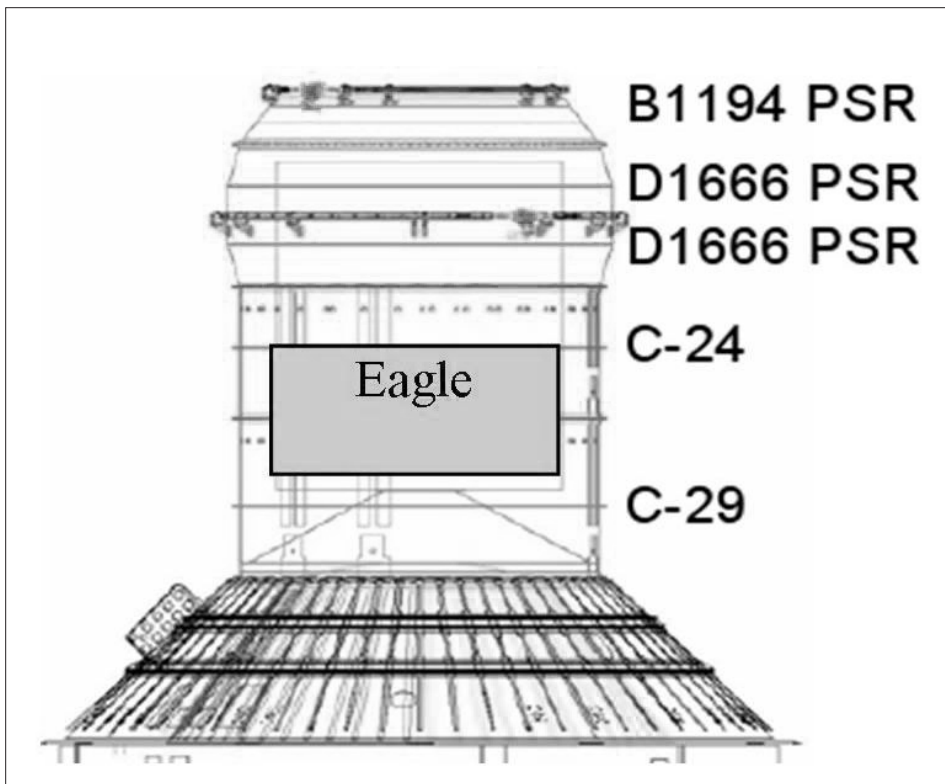


Figure 3: Atlas 5 Internal Payload Carrier (showing where Eagle would fit).

through to completion. These potential supporters want to know that their efforts will be productive and not lost on a project which never reaches completion.

In addition to the costs, there is also now much greater competition for the limited secondary payload opportunities that do arise. In this aspect AMSAT has become a victim of its own success. Sixteen to thirty years ago AMSAT was a pioneer in demonstrating the usefulness of small satellites. Now the ability of small satellites to perform useful missions is becoming widely recognized as evidenced by a 2004 presentation made by SpaceDev forecasting 693 small satellites that will be needing launches between 2002 and 2011. Other studies [2] have also identified hundreds to potentially thousands of small satellites that could be launched if inexpensive launches were available and that this small satellite market has proven to be fairly constant over the last several years. As a result an entire industry has now grown up around small satellites with which we now compete for launch opportunities.

Existing Launch Capabilities

One of the benefits of the growing market of small satellites is that there are an increasing number of options being provided for launching secondary payloads. In addition the definition of “small satellite” continues

to evolve in both the larger and smaller directions. This results in a greater range of options into which we might fit Amateur Radio spacecraft. One of the specific challenges with launching the Phase 3 spacecraft such as AMSAT-DL’s P3-E and AMSAT-NA’s Eagle is that due to power, antenna and stability requirements, they are larger than most amateur spacecraft destined for low Earth orbit. In addition, the energy required to reach the highly elliptical orbit which give the long access durations means that these satellites must fly on the larger launch vehicles.

Delta II - Dual-Payload Attach Fitting

The Delta II Dual-Payload Attach Fitting (DPAF) shown in Figure 1 allows a single Delta II rocket to carrier to spacecraft into orbit [3]. The DPAF is available in two versions, DPAF, shown on the previous page and a reduced height version, RHDPAF. Each is capable of supporting a spacecraft weighing 362.9 kg or 308.4 kg respectively. The RHDPAF allows a lower dimension of 151.7 cm (60 in.) in diameter and 131.5 cm (52 in.) in height. These dimensions provide sufficient volume for the Eagle spacecraft but would require deployable 2 m antennas for P3-E.

Ariane V - Ariane Structure for Auxiliary Payload

As Ariane has transitioned from their early

fleet of launch vehicles to the Ariane V, they have also updated the capabilities of the Ariane Structure for Auxiliary Payload (ASAP) which is now offered as the ASAP5 [4]. The new ASAP5 can include mounting locations for both “mini” and “micro” sized spacecraft. As defined by Arianespace, a microsat can have a mass of up to 120 kg while a minisat is between 120 kg and 300 kg. The ASAP5 is available in three different configurations:

- a combined configuration of up to 2 minisats and 6 microsats (shown on previous page)
- a configuration of up to 4 minisats
- a configuration of up to 6 microsats

Due to their larger size the minisat positions are of interest for Phase 3 satellites as shown in Figure 2. While the microsats allowed for a cube of only 600 mm, the minisat locations permit the mounting of spacecraft that fits within a 1.5 m cube. This volume would easily accommodate the Eagle spacecraft. Making P3-E fit would require adapting the 2 m antennas so that they could be restrained and then deployed once on orbit.

Future Capabilities

Atlas V – Internal Payload Carrier

At the 2007 Small Payload Rideshare Workshop, the Boeing/Lockheed-Martin partnership known as United Launch Alliance (ULA) provided an update on their available secondary payload capabilities utilizing the Atlas V and Delta IV launch vehicles. One example of the Atlas V Internal Payload Carrier (IPC) is shown in Figure 3 where the Eagle satellite would fit. By adding an additional payload separation ring (PSR), the internal volume of the combined C-24 and C-29 spacer rings is then exposed allowing deployment of an additional payload. This internal volume would accommodate a payload of 121 cm (48 in.) O.D. x 152 cm

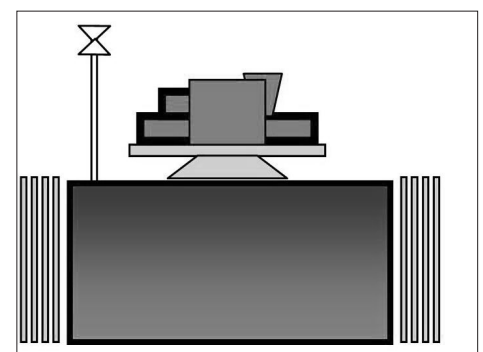


Figure 4: Equipment Platform on an Intelsat Satellite.

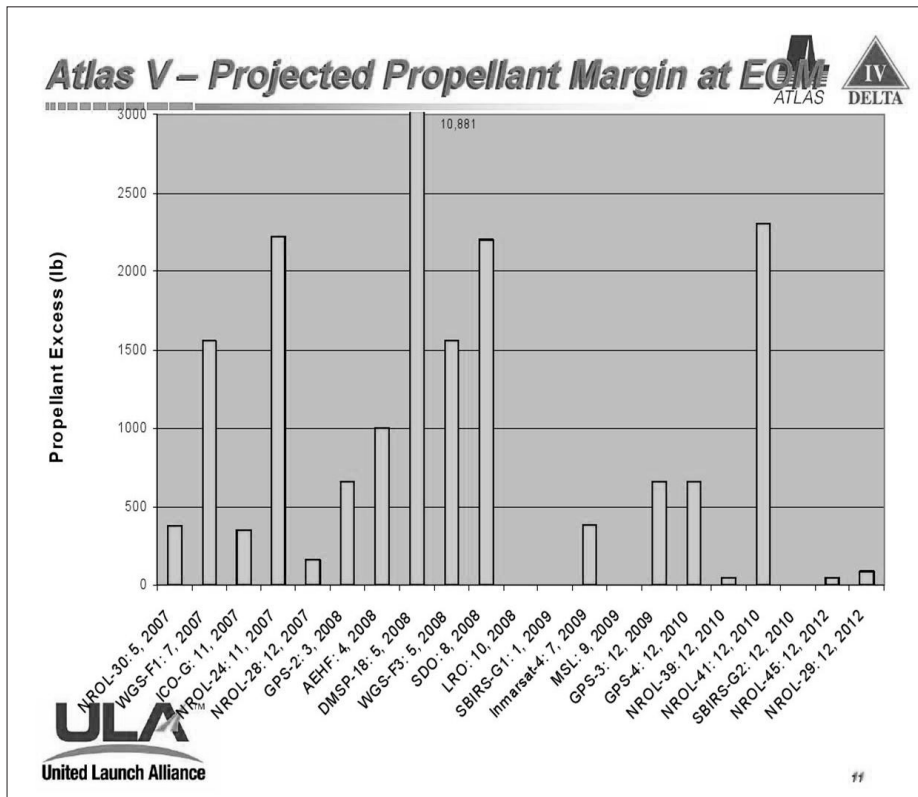


Figure 5 Expected Excess Propellant at End of Atlas/Centaur Missions.

(50 in.) high. While this volume is adequate for Eagle, P3-E's 132.7 cm structure plus antennas would not fit.

In addition to the IPC and other secondary adapters being developed, ULA is also developing a Secondary Payload Integration Lap (SP-SIL) in Denver. The purpose of the SP-SIL is to allow for the complete checkout of mechanical and electrical interfaces prior to arriving at the launch site for integration onto the launch vehicle. This is seen as significantly enhancing the likelihood of success for the secondary payload by eliminating last minute surprises during the launch campaign. Likewise it reduces risk for the primary payload, by providing earlier assurance that the secondary is in fact "as advertised".

Intelsat

Several interesting concepts were presented by Intelsat Satellite Services at the 2007 Small Payload Rideshare Workshop. These included options for both carrying a separating satellite of up to 150 kg or an equipment platform on an Intelsat satellite. Figure 4 shows how each might be integrated onto the nadir face of the host satellite. The box on top of the cone shown in the drawing represents a notional satellite interface using Planetary System's 15 inch motorized LightBand separation system. While the dimensions shown suggest a much smaller

volume than would be needed by P3-E or Eagle, this could provide an option for future follow-on Phase 3 satellites. The benefits of being integrated onto the primary payload are significant and include:

- Advance knowledge of launch opportunities based on a predictable commercial satellite replacement schedule. This is probably the most significant advantage in that it synchronizes the amateur secondary payload development time with the commercial satellite. Instead of needing to be ready once a launch is identified at less than a year, a more predictable 2-3 year project can be planned.
- Lower mass penalties to the overall launch mission due to the elimination of most of the secondary payload adapter mass.
- Shock exposure during launch is significantly reduced due to attenuation by the host satellite structure.
- As a part of the primary satellite the costs, coordination and documentation issues at the launch site are reduced.

Finding Upcoming Launches

As was mentioned earlier in the article, the current short launch vehicle integration cycle makes finding secondary launch opportunities difficult. One approach is

to look for cases where a constellation of satellites are going to be launched. In this way a longer-term insight can be gained regarding launch capabilities. The chart in Figure 5 was presented by ULA at the 2007 Small Payload Rideshare Workshop and shows the expected excess propellant in pounds at the end of the Atlas/Centaur mission. Two satellite programs stand out as potential candidates, Wideband Global Satcom (WGS) and Advanced Extremely High Frequency (AEHF). Both are planned to be constellations of geosynchronous satellites and have 1500 lbs and 1000 lbs of expected excess capacity. Having identified promising candidates, AMSAT is now engaged in discussions to determine whether adequate volume margins exist to support the additional hardware to include Eagle as an IPC mission.

Conclusion

The marketplace in which AMSAT must compete for launch opportunities is constantly changing. New competitors for launch availability as well as new launch vehicle capacity are emerging on an on-going basis. Waiting to support large complex amateur satellite programs such as the Phase 3 satellites until the launch opportunity or date was set no longer a viable option. The Eagle and P3-E projects need your support **now** if we are to be prepared to take advantage of launch opportunities once they are identified.

References

- [1] Originally, "There ain't no such thing as a free lunch" by Robert A. Heinlein in *The Moon Is a Harsh Mistress* (1966), ISBN 0-312-86355-1.
- [2] Marco Carere, "Tracking nontraditional satellite customers", *Aerospace America Online*, October 2003.
- [3] Boeing Launch Services Inc., *Delta II Payload Planners Guide*, July 2006, http://www.boeing.com/defense-space/space/delta/docs/delta2_ppg_2006-07.pdf
- [4] Arianespace, *ASAP5 User's Manual*, May 2000, <http://www.arianespace.com/site/images/ASAP5-manual.pdf>



Report from the 26th AMSAT Space Symposium

The Amateur Radio Satellite Community Gathers In Atlanta

by JoAnne Maenpaa, K9JKM, and Gould Smith, WA4SXM

Welcome to the Symposium

The Amateur Radio Satellite world focused on Atlanta, Georgia over the weekend of October 24-26, 2008 for the Harry Yoneda, JA1ANG, Space Symposium and AMSAT Annual Meeting. Satellite designers, builders, students, old friends and new friends had the opportunity for eyeball QSOs and hours of talking about our favorite topic – Amateur Radio in space.

Two key events made this an important weekend for AMSAT. In addition to the technical symposium and fellowship, the AMSAT Board of Directors met. We'll provide details in this article to inform you of their decisions. AMSAT members also had the opportunity to meet and talk first hand with our officers and board members.



AMSAT President Barry Baines, WD4ASW, welcoming attendees at the 2008 Symposium.

Adding to the fun was the international presence of our good friends from AMSAT-UK, Italy and Germany. Presentations and papers were also received from the UK, Italy, New Zealand and South Africa. Students from the CubeSat programs at Auburn University and Florida International University also gave presentations and their papers are published in the Symposium Proceedings.

The table (next page) shows the list of presentations. There were additional papers submitted where the author was unable to attend to make a personal presentation. All papers are available in the 2008 Symposium

Proceedings book which can be ordered from the AMSAT store.

2008 AMSAT Board Meeting

The AMSAT Board of Directors met on Thursday 23 October 2008 for three, four hour sessions and on Friday for another four hour session before the annual AMSAT Symposium in Atlanta, GA. These open meetings had at various times 3 to 15 visitors during the four sessions. The cozy meeting room served the group and the meeting moved along well and accomplished quite a bit. The complete minutes of the meeting will appear shortly in an upcoming issue of *The AMSAT Journal*. Lee McLamb, KU4OS, has moved from his Executive VP role to that of Corporate Secretary.

The first order of business was to welcome the new board members and to thank Rick Hambly, W2GPS, for his years of service to AMSAT as its president. The board then voted on a new president recommended by a presidential search committee lead by Gunther Meisse, W8GSM. Barry Baines, WD4ASW, was elected by a vote of 6-1. See Barry's initial Apogee View in the September/October issue of *The AMSAT*

Journal and in this issue where he discusses his plans and challenges for AMSAT. Most of the officers were elected, but there are a few vacancies at this time – Executive VP, VP of Engineering, and VP Marketing.

Rick Hambly gave the President's report to the group and expressed his concern for the organization if there is not more involvement from the officers and membership. Barry explained to the group that the role of the board was to set policy and the role of the officers was to implement the policies. Gunther gave the Treasurer's report and noted that AMSAT's investment had taken a hit (as has everyone's) this year. The Web

site is now under Gunther's guidance. He announced that the consolidated AMSAT Information Management System (AIMS) database is being brought online for testing and that the AMSAT server is moving from Rick's to Gunther's company until the AMSAT office has sufficient bandwidth to accommodate it. Rick is also serving as Web master until another volunteer is available.

Martha Saragovitz, AMSAT Manager, reported that the AMSAT Store being down for a number of months had an impact on new memberships, as most new members join through the store. Software sales were down, but book sales remained steady. Martha also noted a need for someone to design new print ads for AMSAT.

Drew Glasbrenner, KO4MA, gave a report to the board on the operations team. AO-7 is working well and suggested that they may try some commands before the eclipse season starts. AO-16 is approaching its final season of usability for quite a while. AO-51 is in full sun again, enabling us to run 700mW on both transmitters. There has also been a good deal of L- and S-band operation, in a number of different configurations. Drew noted that he may refresh the AO-51 modes team. He also appealed for more volunteers to work with the Boy Scouts during JOTA operations.

Tim Lilley, N3TL, presented a number of good suggestions to the group on how better to market the organization and he is pursuing these activities. Tim also obtained donations of a Yaesu FT-60 handheld radio and an Elk antenna for a 'satellite starter kit'. These were presented as a prize to the newest licensed operator at the AMSAT banquet.

Gould Smith, WA4SXM, presented the User Services report to the board. It was a productive year for the User Services group. The *Journal* has been a little behind schedule due to lack of articles, the ANS has done an outstanding job in finding and releasing the weekly news about the amateur satellite world. The number of awards issued and the number of satellite Field Day contacts were also up. AMSAT was represented at 40 hamfests during the year, a decrease from the last two years. Dayton was very successful. We had a extra booth space in which we used to showcase and discuss AMSAT engineering events. The outdoor satellite

Presentations at the 2008 Space Symposium



Tony Monteiro, AA2TX, talking about his Space Radio concept.

demo was well attended; the AMSAT-TAPR banquet in the new venue was well received. We also took in more funds than the previous year, and total memberships were the same as last year.

Rick Hambly gave the engineering report. The group that had hosted the AMSAT Lab changed from a non-profit to a for-profit organization and we are in negotiations to remove the clean room and other AMSAT properties. The engineering team was disassembled during the summer. Some groups are forming to work on specific projects like ACP. A new team was formed to determine near term satellite opportunities. Jim Heck, G3WGM, reported that AMSAT-DL was now renting space that the current P3E lab is using and trying to find a launch as well as working with the German government on funding for P5A.

ITAR continues to present challenges to the engineering team. A team was setup to work with a lawyer to clarify AMSAT's position and to work toward an environment that we can work with groups in other countries on

Presenter	Title
Anthony Monteiro, AA2TX	Space Radio for Windows
Mark Hammond, N8MH	Recovering AO-16
Bill Brown, WB8ELK	Amateur Radio Balloon Flight - Crossing the Atlantic
Paul Marsh, M0EYT	S-band and X-band deep space reception
Tim Salo, AB0DO	Proposed Network-Centric Architecture for the ACP
JoAnne Maenpaa, K9JKM	AMSAT Opportunities for Communications Interoperability
Richard Chapman, KC4IFB, Jean Marie Wersinger KI4YAU; Thor Wilson; John Klingelhoefter, WB4LNM	AubieSat1: A Student Designed CubeSat Developed at Auburn University
David Bowman, G0MRF	Medium Earth Orbit - An Affordable Alternative to HEO
Joe Lynch, N6CL	The Meteor Shower Nobody Saw - Revisited
Tim Lilley, N3TL	Handheld FM Satellite Stations: Meeting FCC Part 97.1 with a Superb Tool for Recruiting New Operators
Tom Clark, K3IO	Taking Eagle to New Heights: A Strawman Design for a Geostationary Amateur Satellite
Frank Bauer, KA3HDO	ARISS
Lou McFadin, W5DID	SuitSat-2/Radioskaf-2: The second Amateur Radio Space Suit project and stepping stone to future small amateur satellites
Christian Rodriguez, Henric Boiardt Florida International University	Using Iridium's satellite network for amateur satellite communications in Low Earth Orbit
Bill Ress, N6GHZ	ITAR and AMSAT
Phil Karn, KA9Q	Power- efficient FEC- coded low rate telemetry formats
Giulio Pezzi, IZ4FVW/AB2VY	HSSDT Project - High Speed Satellite Data Transmitter
Gould Smith, WA4SXM	AO-51 Operations Before, During and After the No Eclipse Period
Fred Kennedy, ZL1BYP	KiwiSat, A Communications Satellite for New Zealand (presented by Bill Ress, N6GHZ)
Hans van de Groenendaal, ZS6ZKV	SumbandilaSat Up October 19 (presented by Gould Smith, WA4SXM)
Howard Long, G6LVB	P3E's Software Defined Transponder (SDX)
Phil Harman, VK6APH	Introduction to Digital Signal Processing

amateur satellite activities.

It has become obvious that we need a great deal of funding to pursue GEO and GTO launch opportunities. We need to start getting the funding together now and have some hardware to demonstrate our capabilities. Rick noted that most schools building satellites have aeronautical engineering emphasis rather than electrical. We have a good opportunity to provide communications

systems for them.

Frank Bauer, KA3HDO, gave his report on human space flight via telephone. He lauded the huge impact of the Richard Garriott, W5LFL, flight for both the voice and SSTV activities. The next space tourist, Charles Simonyi is scheduled for his second flight

and already a licensed amateur. SuitSat-2 progress has been impressive over the past 6 months and a launch is anticipated in 2009. The new V/U antennas to be sent up and installed on the Columbus module will provide additional access for Amateur Radio opportunities aboard the ISS. We expect Mike Finke to be quite active doing school contacts and other Amateur Radio activities during his six month stay aboard the ISS.

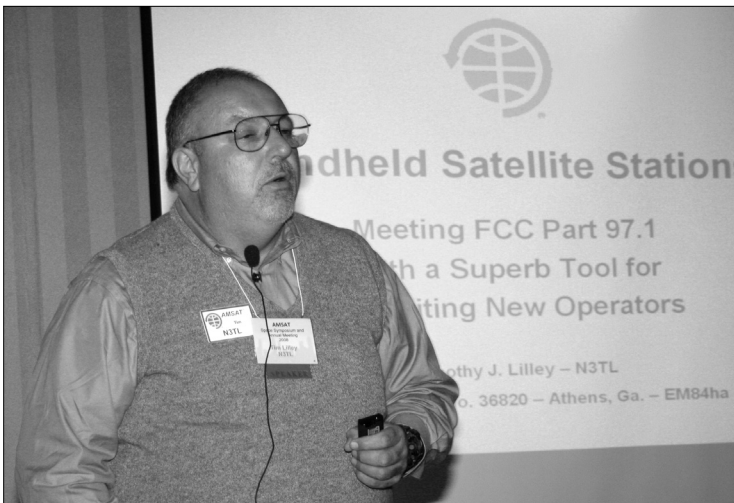
Highlights of the 2008 AMSAT General Meeting

The 2008 AMSAT-NA General Membership Meeting was called to order by President Barry Baines, WD4ASW. The meeting was also carried on the AMSAT EchoLink Channel. Members are invited to view the PowerPoint slides which Barry presented. See: http://www.amsat.org/amsat-new/pdfs/2008_Annual_Meeting/2008-10-25_WD4ASW_Annual_Meeting.pdf.

Introducing the AMSAT Board Members

The AMSAT Board of Directors and their term of office currently consists of:

Barry Baines, WD4ASW (2009)
Drew Glasbrenner, KO4MA (2009)



Tim Lilley, N3TL, talking about satellite operation via handheld radio.





Some of the Presidential Award winners Barry, WD4ASW; Gould, WA4SXM; Dan, N8FGV; Drew, KO4MA; Frank, KA3HDO and Martha, AMSAT office manager.

Rick Hambly, W2GPS (2009)
 Gunther Meisse, W8GSM (2009)
 Tom Clark, K3IO (2010)
 Lou McFadin, W5DID (2010)
 Gould Smith, WA4SXM (2010)
 Bill Ress, N6GHZ (Alternate)

Immediate Past President Rick Hambly, W2GPS, received the thanks of the board and all of AMSAT for the 4 years of service he has given as president. Rick's faithful and extensive service to AMSAT has moved AMSAT forward in a number of areas, including:

- Dealing with changes in the regulatory environment (orbital debris)
- Establishing a relationship with University of Maryland-Eastern Shore that resulted in relocation of the AMSAT Integration Lab to Pocomoke, MD,
- Working on the difficult issue of ITAR (International Traffic of Arms Regulations),
- Revamping the AMSAT senior leadership team organizational structure,

- Initial discussions with Intelsat on a possible 'rideshare' opportunity,
- Filling in as our Web master when we lost the volunteer who handled that function.

Much of what Rick did was 'behind the scenes' activities that took many hours, required dedicated follow-up, and received little fanfare. Many thanks go to Rick for his significant efforts to make AMSAT better. During the past four years, no one dedicated such a significant portion of their life to AMSAT as Rick.

AMSAT's Senior Leadership Team structure was discussed with the membership. Our team for 2008-2009 consists of these people:

President: Barry Baines, WD4ASW
 Executive VP: OPEN
 VP Operations: Drew Glasbrenner, KO4MA
 VP User Services: Gould Smith, WA4SXM
 VP Engineering: OPEN

VP Marketing: OPEN
 Secretary: Lee McLamb, KU4OS
 Treasurer: Gunther Meisse W8GSM
 Manager: Martha Saragovitz

Barry discussed how in the near term the SuitSat-2 presents a considerable opportunity and is quite important to our future satellite payloads. The Software Defined Transponder (SDX) will receive its first space flight test when it is deployed in the space suit. World attention will once again be focused on this project due to its unique nature. The educational program tied with SuitSat-2 has been expanded on an international scale to include elementary through university programs. Lou McFadin, W5DID, continues to lead this project.

The Geostationary Rideshare project continues to present unparalleled opportunity for AMSAT. Barry reported that active discussions with the satellite owner are on-going. AMSAT has had to enter into non-disclosure agreements so that we may continue to participate in rideshare



AMSAT Banquet 2008.



Dan Schultz, N8FGV, featured speaker at the 2008 AMSAT Banquet.

discussions with the primary payload as well as other secondary payload participants. The satellite owner provided design drawings to AMSAT so we can propose our mission. Tom Clark, K3IO, has created a proposal in response which features a modular approach to the payload design for this environment, preliminary interface specification, engineering standards and a study of probable limitations with workarounds depending on our position on the primary satellite's structure. The impact to the engineering budget is under analysis at this time.

Barry pointed out that AMSAT will continue to research and be aware of all launch opportunities even while the geostationary rideshare proposal is being pursued.

AMSAT currently faces some challenges. The AMSAT lab in Maryland is closed

at this time because of changes in the corporate structure of the Hawk Institute for Space Sciences (HISS) at the University of Maryland, Eastern Shore. AMSAT has retained an attorney to ensure our property rights for the equipment already in place in the lab. We are looking for a suitable laboratory environment from which to resume our satellite operations, construction, and educational programs.

The AMSAT-NA engineering department is undergoing restructuring after the resignation of the Vice President of Engineering. The ACP Ground Station project is on hold at the present time as well. The Board of Directors has established a near-term task force to address these challenges. The "Next Steps" team will consist of five members. The members at present include:

Bill Ress, N6GHZ

Drew Glasbrenner, KO4MA

Tony Monteiro, AA2TX

Lou McFadin, W5DID

One additional member is to be nominated

The board recognized that volunteers should also be encouraged to develop satellite projects on their own initiative. The goal includes attracting new volunteers who will form small teams focused on particular areas of interest. This would lead to an open organizational structure in an open development environment addressing hardware design, software, radio, antenna, power system development. As a result the next Vice President of Engineering will need to be an individual who is interested in and is capable of project management of diverse teams and who will provide the liaison focal point between the teams and the rest of AMSAT. Mentoring will be a critical skill!

AMSAT will continue to pursue a workable strategy to deal with potential international cooperation limitations imposed by the International Traffic of Arms Regulations (ITAR) statute. The board will seek legal counsel to develop a plan to move forward with amateur satellite cooperation with AMSAT-UK and AMSAT-DL. Also under study will be legal exemptions for AMSAT's amateur and educational activities. The legal counsel will also be used to develop and document lessons learned, address member concerns, and develop guidelines for members and officers to ensure compliance with the law while at the same time permitting reasonable pursuit of the international nature of Amateur Radio projects and communications.

Barry discussed the updated AMSAT Vision Statement which was modified at the Board of Director's meeting to remove old dates to focus on end results of deploying amateur satellites. The board also has goals of investigating and pursuing all appropriate (and affordable) launch opportunities to MEO, HEO and Rideshare orbits. AMSAT will need to recruit and develop the next generation of satellite builders. As of October, 2008 AMSAT's Vision Statement reads:

AMSAT will deploy satellite systems for wide area and continuous coverage

AMSAT will continue participation in human space missions

AMSAT will support a stream of LEO



Symposium Grand prize winners Flo Bower with the TS-2000 and Judy Perkins, KE7ERI, with the IC-910H. [Look at those happy smiles! – Ed.]

continued on page 16 ...





AMSAT-UK Colloquium 2009

This year the AMSAT-UK International Space Colloquium will be held from **Friday, July 24 to Sunday, July 26** at the **University of Manchester** right in the center of the city and within 200 meters of Piccadilly Railway Station. The station has direct trains to Manchester Airport and there is also an hourly bus service from the Liverpool John Lennon Airport.

This 3 day event attracts an international audience of those involved in building and operating Amateur Radio satellites and CubeSats. Details of this and previous events can be found at: <http://www.uk.amsat.org/colloquium>

AMSAT-UK invites speakers, about Amateur Radio space and associated activities, for this event. They are also invited to submit papers for the "Proceedings" document that will be published at the same time, but printed papers are not mandatory. We also welcome "unpresented" papers for the Proceedings document. Offers of talks should be submitted as soon as possible. The final date for full documents to be received is late June so that the "Proceedings" document can be available to participants. Submissions should e-mailed to: david.johnson@blackpepper.co.uk

The new RSGB GB4FUN radio communications trailer, which has a fully equipped satellite station, will be available during the event for visitors to work the satellites. The event is open to all radio amateurs and SWL's. Either day passes or full packages comprising overnight accommodation and meals are available.

The AMSAT-UK Colloquium Web page is: <http://www.uk.amsat.org/colloquium>

AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista.

Version 12.8 has improved Windows Vista compatibility and enhanced support for tuning multiple radios.

Version 12.8 Features:

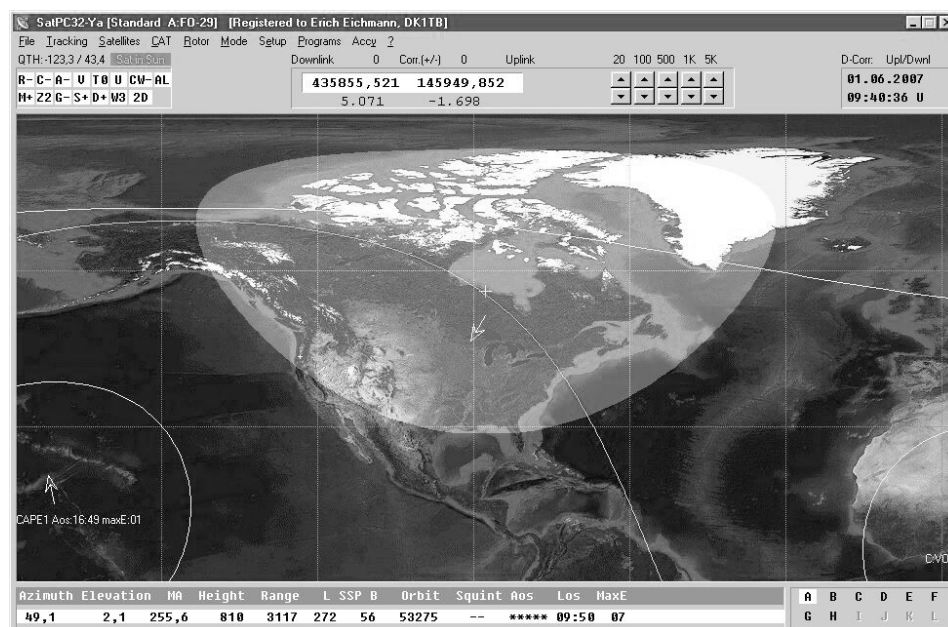
- Select 2D/3D map with a single mouse click
- Select Political/Physical map with a single mouse click
- AOS voice announcement
- Countdown program displays next AOS of your favorite satellites
- Automatic Internet download of Keplerian elements.
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- Doppler tuning with on-screen frequency displays. Radio models supported:
 - Yaesu FT-847, FT-736R, FT-817, FT-857, FT-897
 - ICOM IC-820H, IC-821H, IC-910H and other ICOM radios
 - Kenwood TS-790 and TS-2000
 - DDE client programs
- "Transparent" VFO-knob tuning in addition to keyboard and mouse tuning.
- "Virtual" VFO tracking for half-duplex transceivers FT-817, FT-857, FT-897, IC-706 and IC-7000.
- Includes a special version for ISS split-frequency operation.
- Controls subaudible tone on FT-847, FT-736R, FT-817/857/897, TS790A and IC-910H.
- Includes a non-graphical version and programs that output lists to the screen, printer, or a file.
- Interfaces with WiSP, with user-defined satellite switching priority.
- Includes a separate program for tracking the Sun and Moon.

Price is \$45 for AMSAT members, \$50 for non-members, on CD-ROM.

A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>

A registration password for the demo version is \$40 (members), \$45 (non-members). Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.





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Contact Martha at the AMSAT office 301-589-6062 to order.

The complete units will be built in groups, so get your orders in early.

Units will be shipped as they become available.

- 1) Bare board - \$20 + S&H - no parts kits available
- 2) Populated board, serial interface - \$100 + S&H - no kit with USB unit, rotor cable and LCD available, we do have a parts list with recommended part numbers and sources.
- 3) Custom Ten-Tec Enclosure powder coat, silk-screened, drilled/punched - \$50 + S&H
- 4) Complete unit - board, USB output, rotor cable, LCD, enclosure - \$200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: <http://www.LVBTracker.com>

Boards and complete units may be ordered from the AMSAT office at 301-589-6062 or from martha@amsat.org

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The 2008 Board meeting. Photo by Dave Jordan, AA4KN.

satellites in cooperation with the educational community, and other amateur satellite groups.

AMSAT has plenty of work ahead for the coming year. Members left the meeting with a better understanding of the opportunities and challenges facing our goal to deploy Amateur Radio satellites. We'll see you at the 2009 Symposium!

Let's Eat! AMSAT's Annual Banquet on Saturday Evening

The Annual Banquet featured Dan Schultz, N8FGV, a masterful speaker, who through excellent slides and dry wit explained the upcoming Hubble Repair Mission from an insider's perspective. In addition, for the first time in our history, there were two major prizes given away at the dinner (Icom IC-910H and a Kenwood TS-2000), both of which were won by women who attended the banquet. Judy Perkins, KE7ERI, of Lilburn, GA won the IC-910 and Flo Bower of Pinson, AL won the TS-2000 (she is working on earning her ham license). Many thanks go to both Icom and Kenwood for their support of AMSAT. A special prize was a beginner's satellite station awarded to the most recently licensed participant at the Symposium which went to London Kenton, KJ4HCQ.

Area Coordinator Breakfast on Sunday Morning

Twenty-seven AMSAT Area Coordinators assembled early Sunday morning to have breakfast and discuss AMSAT Field Operations activities. Gould Smith, WA4SXM, gave the group a PowerPoint presentation on Field Operations accomplishments over the last

year. He also announced that long time Area Coordinator Dee Interdonato, NB2F, will assume many of the Field Operations duties. The group discussed ways in which we could better serve the amateur satellite community.

Introduction to Digital Signal Processing Workshop

Phil Harman, VK6APH, presented a 2+ hour DSP workshop Sunday morning. Phil's interesting and practical approach to learning about DSP does not only teach the theory, but provides common, inexpensive tools. These tools allow the learner to develop practical DSP-based test equipment and "learn by doing". The workshop was well attended and well received. Thanks to Phil for developing this workshop.

See You Next Year – 2009 Symposium in Baltimore

The 2009 AMSAT Space Symposium and Annual Meeting will be held on October 9th and 10th. On the 11th and 12th, there will be an ARISS meeting open to the membership. The meetings will be held at the Sheraton Four Points at BWI Airport. 2009 will be the 40th Anniversary of AMSAT. We hope many of you will be able to come and help us celebrate.

2008 AMSAT Presidential Achievement Awards

AMSAT's board of directors and officers recognized the following people for their work and effort to ensure a successful year:

Note: The recipients received plaques with

the inscriptions as follows:

J. C. Taylor, W3JCT, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his extraordinary efforts most weekends for the last year and a half to setup the AMSAT Spacecraft Integration Lab. His efforts to clean, organize and setup AMSAT's lab, including the huge clean room, have been invaluable! Also his local outreach on behalf of AMSAT is very much appreciated.

Ray Fantini, KA3EKH, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his extraordinary efforts most weekends for the last year and a half to setup the AMSAT Spacecraft Integration Lab. His efforts to clean, organize and setup AMSAT's lab, including the huge clean room, have been invaluable!

Kaitlyn Fantini is awarded the 2008 AMSAT Presidential Achievement Award in recognition of her volunteer spirit on many Saturdays at the AMSAT Spacecraft Integration Lab. Her willingness to learn new things made her a valuable volunteer!

Megan Fantini is awarded the 2008 AMSAT Presidential Achievement Award in recognition of her volunteer spirit on several Saturdays at the AMSAT Spacecraft Integration Lab. Her willingness to learn new things made her a valuable volunteer!

Steve Christie is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts on clean room assembly at the AMSAT Spacecraft Integration Lab and his efforts towards

mechanical modeling of Eagle. Your continued interest in helping the mechanical design of Eagle is appreciated.

Rob Renoud, K3RWR, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts preparing and assembling the clean room at the AMSAT Spacecraft Integration Lab. His efforts, especially during the early clean room preparation, were invaluable!

Brian Gaffney, K3PU, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts preparing and assembling the clean room at the AMSAT Spacecraft Integration Lab. His efforts, especially during the early clean room preparation, were invaluable!

Martin Jackman is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts to assemble the clean room at the AMSAT Spacecraft Integration Lab. His volunteer Saturdays are very much appreciated! Good luck with the remainder of your degree!

Roland Coelho, WH7BE, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts to move AMSAT equipment into the newly completed AMSAT Spacecraft Integration Lab.

Ken Blake is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts to help unpack the trucks from Orlando, and help assemble the clean room and for his patience with Bob on the drive from Orlando to Pocomoke. Your continued interest in helping with Eagle mechanical design is appreciated.

Steve Fannesbeck, KB3OHF, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts to help assemble the clean room at the AMSAT Spacecraft Integration Lab.

Drew Glasbrenner, KO4MA, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his outstanding dedication and leadership as Vice President of Operations and leader of the satellite operations team and his extraordinary efforts to pack, transport and unpack AMSAT property as part of the Spacecraft Integration Lab move from Orlando to Maryland.

Bob McGwier, N4HY, is awarded the 2008 AMSAT Presidential Achievement Award in recognition for his vision and efforts to help manage the AMSAT Spacecraft Integration Lab, and his several trips to the lab. His

volunteer efforts over several business days and countless evenings and weekends have been instrumental in our efforts at the lab for the last 2 years including driving a truck from Orlando to Pocomoke.

Barry Baines, WD4ASW, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your dedication and leadership in helping AMSAT maintain its preeminent role in the Amateur Radio community by assuring that the AMSAT Board of Directors and AMSAT's Executive Team continue to evaluate AMSAT's goal and objectives and by working to maximize AMSAT's effectiveness in all areas.

Martha Saragovitz is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your dedication to AMSAT especially as Manager of the AMSAT office and other AMSAT affairs. Your ability to work with people both within the leadership and with the membership at large during difficult times is a strong force for the good of the AMSAT community.

Gould Smith, WA4SXM, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your dedication to AMSAT especially as Vice President User Services, your pivotal role in the Suit Sat project and serving as the primary command station for AO-51. Thank you for your outstanding dedication and untiring hard work. Your leadership has had a positive impact on those around you and has generated a sense of order and purpose to the tasks with which you have been involved.

Gunther Meisse, W8GSM, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your leadership as AMSAT Treasurer and as a member of the AMSAT Board of Directors. You have substantially improved AMSAT's accounting practices, qualified AMSAT for participation in the Combined Federal Campaign (CFC) and initiated a number of important fund raising activities.

Frank Bauer, KA3HDO, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your leadership and commitment to the Amateur Radio on the International Space Station (ARISS) program that has resulted in ARISS continuing its preeminent position in space education and outreach to students and teachers.

Bob Davis, KF4KSS, is awarded the 2008 AMSAT Presidential Achievement Award

in recognition of your leadership in running the AMSAT Spacecraft Integration Lab. This includes organizing work parties that resulted in the rehabilitation of the AMSAT Clean Room and other AMSAT equipment in addition to providing an Eagle structure mockup that was displayed at Dayton.

Richard Crow, N2SPI, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your dedication to space education especially for hosting the AMSAT Antenna Workshop at the 2007 AMSAT Symposium and for publishing the "Learn DSP by Programming Your PC" series in *The AMSAT Journal*.

Dan Schultz, N8FGV, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your superior work in obtaining the technical papers, editing the Proceedings for the 2006 and 2007 AMSAT Symposiums and for producing the 2007 AMSAT Symposium CDROM. This award also recognizes that you volunteered to take on this difficult task for the 2008 AMSAT Symposium.

Mike Young, WB8CXO, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many days of volunteer work on the LVB Tracker box in ordering parts, building, assembling and testing over 120 LVB Trackers during the last year. Your creative demonstration unit at Dayton was invaluable in showcasing this product, as were your hours spent setting up and working the AMSAT booth. Your willingness to build these units and to provide a quality product is in the true spirit on an AMSAT volunteer.

Lee McLamb, KU4OS, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your continued efforts as co-editor to faithfully provide the AMSAT community with the weekly AMSAT News Service (ANS). This service keeps the amateur satellite community informed and abreast of the important events relevant to satellite communications. The ANS continues to act as the major information conduit for our organization.

JoAnne Maenpaa, K9JKM, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your continued efforts as both the Chief Editor and a co-editor to faithfully provide the AMSAT community with the weekly AMSAT News Service (ANS). This service keeps the amateur satellite community informed and



abreast of the important events relevant to satellite communications. The ANS continues to act as the major information conduit for our organization.

Dee Interdonato, NB2F, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many efforts on AMSAT's behalf. You have again well represented AMSAT at hamfests, given talks and satellite demonstrations this year. Your continued efforts prove that you are a model Area Coordinator. You want the best for AMSAT and the Field Ops team and work to get that accomplished. In addition your efforts to co-edit the ANS every month and volunteer time at Dayton each year make you a very valuable resource for AMSAT.

Ed Long, WA4SWJ, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your herculean effort this past year in getting *The AMSAT Journal* edited, assembled, laid out and to the publisher this year while facing a severe lack of content. Thank You for an outstanding job in producing a publication that the membership looks forward to receiving.

Patrick Stoddard, WD9EWK, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many contributions to the AMSAT Field Ops team. Your leadership in providing AMSAT presence at hamfests in the Phoenix area, performing multiple satellite demonstrations and satellite talks have all greatly enhanced the satellite operations from Arizona and around the country. You have also proven to be a valuable member of the AO-51 Operations team.

Keith Pugh, W5IU, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your continued multiple contributions. Your efforts as net control for the 20 m AMSAT net and for multiple ham club talks and demonstrations during the year continue to showcase AMSAT. In addition, your multi-day operations at Dayton and HAMCOM in Dallas are a testament to your ability and dedication. Your service as an ARISS Mentor has been extremely valuable. The well chosen words used in your CQ VHF Satellite column continues to keep AMSAT activities highlighted to all its readers.

Bruce Paige, KK5DO, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many contributions to AMSAT over the last year. These include the weekly satellite award notices and your well

managed amateur satellite contests. Your Houston AMSAT Net provides a worldwide forum and news source for all amateur satellite operators. The Houston AMSAT Net Web site is a useful complement to the AMSAT Web site. In addition, your work with the AMSAT Store is invaluable and much appreciated.

Clint Bradford, K6LCS, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your exuberant work as an AMSAT Area Coordinator in locating opportunities to speak about AMSAT and amateur satellite operation, organize booths for AMSAT at hamfests and fairs. In addition you developed materials for working amateur satellites with a handheld to encourage newcomers to satellites and future AMSAT members.

Chuck Pinkham, K3PER, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many years of tireless effort for AMSAT during the Dayton Hamvention. Your invaluable contributions at booth setup, long daily stints working the booth and then helping with booth take down and storage exemplify the greatest qualities of a true selfless volunteer. Your efforts are truly appreciated and counted on. We hope you will continue to be an integral part of the AMSAT Dayton experience.

Steve Belter, N9IP, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of your many contributions to the AMSAT effort at Dayton this year and in former years. Your volunteer spirit to do whatever was needed and to fill in as needed exemplify the greatest qualities of a volunteer. You identify a need and work to solve it, a quality much appreciated by the Dayton team. We look forward to your continued presence at Dayton in making it better each year.

Mark Hammond, N8MH, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts in the very difficult job of recovering and restoring use to AO-16. With limited information and resources, he exhibited determination and vigor in accomplishing this task. The renewed life of AO-16 is due to the donation of his time and talent to AMSAT and its members. Mark also serves on the AO-51 Scheduling committee. Thank you Mark for your hard work.

Jim White, WD0E, is awarded the 2008 AMSAT Presidential Achievement Award in

recognition of the invaluable knowledge and guidance to the AO-16 and AO-51 command teams, passing on technical information, management strategies, and lessons learned from his long-term experience with AMSAT projects which Jim has provided. Thank you for your continued involvement in AMSAT.

Bruce Rahn, WB9ANQ, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts serving as mentor and teacher to the team working to recover AO-16 and providing valuable insight and experience when needed most. Thank you for your dedication and willingness to help when needed most.

Mike Rupprecht, DK3WN, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his efforts providing valuable software packages for decoding telemetry from AO-16 and many other satellites which greatly streamlined the command process. Additionally his work provided easier access to satellite telemetry for AMSAT users worldwide. Thank you Mike for your software work for AMSAT worldwide.

Kevin Schuchmann, WA6FWF, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his work as the west coast AO-51 command station, providing important redundancy and geographic diversity to the command team. Additionally, Kevin supported the Sputnik 50th Anniversary event by providing QSLs for all who sent cards. Thank you Kevin for your continuing support of AMSAT.

Robin Cutshaw, AA4RC, is awarded the 2008 AMSAT Presidential Achievement Award in recognition of his work leading the team that organized the 2009 AMSAT Symposium and Annual Meeting in Atlanta, GA. Your work in soliciting prizes, communicating with the host hotel, providing audio resources and setting up the live AMSAT meeting via Echolink were very well received and appreciated. Thank you for a great experience at the 2009 AMSAT Symposium. ☸

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Help Wanted AMSAT needs qualified volunteers for a number of positions!

If you want to be a part of the solution in making AMSAT operational and work toward designing, building and finding a launch, WE NEED YOU!

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- Educational activities
- Promoting AMSAT as an Area Coordinator



and any other area you think you think you can make a difference.

We often have people volunteer, but many don't deliver on their promises. So, pick an area that you think needs improvement and explain what you will do to make it better. Then do something to show that you can follow through.

Send your suggestions, actions plans and a description of why you are capable of doing this task to Gould Smith, WA4SXM, wa4sxm@amsat.org

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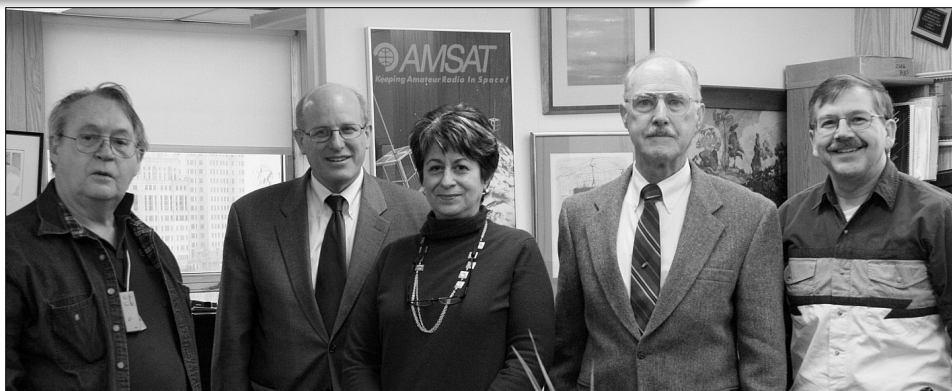
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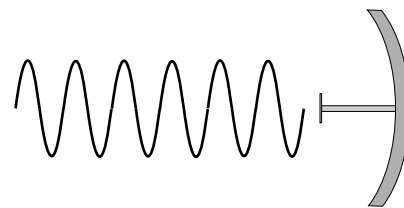
THANK YOU!





This photo was taken in the AMSAT office on January 17th at a meeting with AMSAT's ITAR lawyer, Frank Schuchat. The meeting was to discuss the AMSAT's approach to the State Department to insure full compliance with the government rules on ITAR (International Traffic in Arms Regulations) -- satellites, motors, some software and many components of a satellite are considered to be MUNITIONS and their export to other countries is considered as Traffic in Arms!

Left to right: Tom Clark, K3IO; Frank Schuchat, Martha Saragovitz, Dick Daniels, W4PUJ; & Frank Bauer, KA3HDO.



Accomplishments

Congratulations Joe, K3SZH, for 8000 QSOs via AO-7. Joe was copied in Brazil by PU2BFG in Mode B. Jean, F2IL, has now completed 4000 plus QSOs via AO7. Congratulations Zlatko, 9A2SB, on your 1000 plus QSOs on AO7 in modes A&B. On January 15 Clare, VE3NPC, worked CU2JX via AO-51 mode L/U.

Patrick Stoddard, WD9EWK, earned the AMSAT W4AMI 5,000 Satellite Communication Achievement Award #21.

Listen for KAGAYAKI Satellite

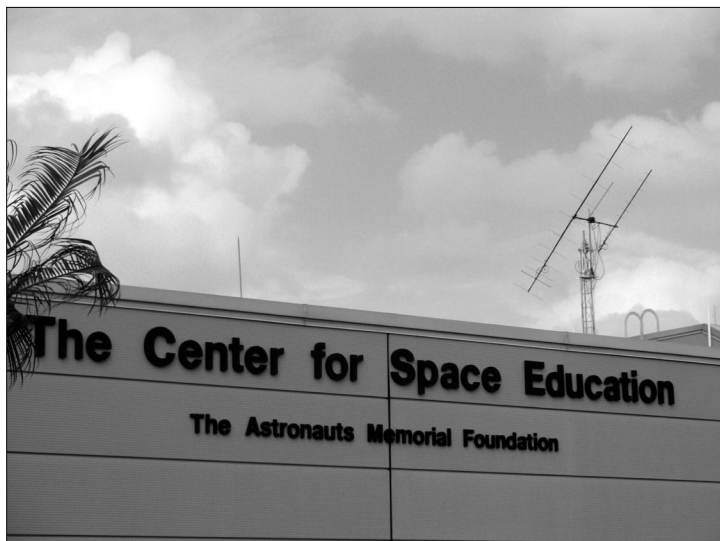
The KAGAYAKI satellite has not been heard since it was launched with Japan's January 23 GOSAT satellite. KAGAYAKI was to transmit morse code on FM after separation from the H-2A booster.

If operational KAGAYAKI should be transmitting morse code on FM or 9600bps packet at 437.375MHz. The command team thinks the satellite's output power may very low because the antenna or solar panel has not extended properly. Ground controllers have been searching for a downlink signal using a spectrum analyzer. The satellite is thought to be Object D in the AMSAT keplerian elements.

Please monitor for KAGAYAKI. If heard please send your report to Masa, JN1GKZ, (m-arai@a.email.ne.jp) and he will relay the information to the command station.

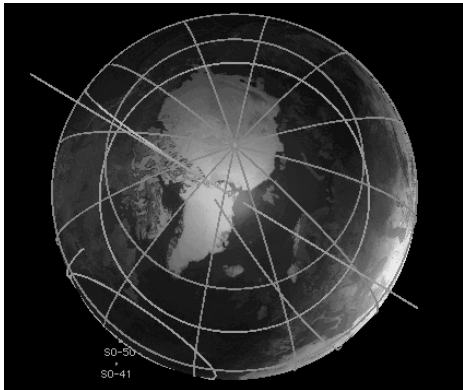
Ground Station at Kennedy Space Center

Several AMSAT volunteers have been working together with the Florida Space Institute to establish an Amateur Radio satellite and high altitude balloon ground station at the Kennedy Space Center Visitor's Center in Florida. The new station is located in the Astronaut Memorial Foundation's Center for Space Education just to the North and West of the "rocket garden". More details will be in an upcoming *Journal* article.



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ITAR (and other export control rules) and AMSAT

by Bill Ress, N6GHZ, n6ghz@amsat.org

Alternate AMSAT Board Member

Background

AMSAT-NA is facing a critical crossroad in its attempts to support international development of amateur satellites because of the implications of various export control rules, primarily ITAR. If we can't get an acceptable handle on ITAR issues, there seems to be a reluctant acceptance that AMSAT-NA may indeed be forced to go it alone in terms of developing satellites.

What Key U.S. Export Control Laws Affect AMSAT-NA?

U.S. export control laws that protect national security and trade are the International Traffic in Arms Regulations (ITAR), implemented by the U.S. Department of State and the Export Administration Regulations (EAR), implemented by the U.S. Department of Commerce.

EAR covers the export of "dual-use" items. These are typically commodity items, which could have military applications, or be modified to have a military application. An example would be a microwave amplifier device that is designed to operate at about 31 GHz. To export this item you would need an export license from the Department of Commerce.

The Department of State Directorate of Defense Trade Controls (DDTC) administers ITAR [1]. ITAR covers the export of items that have intended military applications. An example would be a surface to air missile. ITAR doesn't say you CAN'T export that surface to air missile, but it does say you must receive an export license from the Department of State, using well-documented procedures.

You probably wonder, "But we're designing and building satellites just for amateur use on authorized ITU amateur satellite bands. Why are we affected?" The simple answer is that we are involved in designing satellites and their components, and many aspects of satellites and their components are considered by ITAR as a "defense item", which are regulated by the US Government if exported. I have emphasized export because our primary concern is with the export of satellites and satellite technology and components. So if AMSAT-NA designs and builds satellite components and satellites by U.S. citizens and has them launched by US launch companies from the US, the impacts

of the export laws, such as ITAR, do not apply. So AMSAT-NA volunteers can, and should, continue to design and build for our satellite programs which fall under the above criteria. Since AMSAT-NA had to become a registered arms exporter with the State Department, we can even design and build satellites with other US citizens, and have them exported for launch in a non-US country.

I keep emphasizing "US citizens" because when we enter into technical discussion about the parts of our satellite covered under ITAR, with foreign nationals, whether they are in the US or in any other country, we could violate the most troublesome part of ITAR called "deemed exports." The definition of an export is not limited to sending goods overseas; it also applies to the release of technical data to foreign nationals. It can occur simply by mailing data to or engaging in a conversation with a foreign national. Foreign nationals are defined as those persons that are not US citizens, do not hold Green Card status and are not under asylum in the United States. This transfer of data can take place entirely within the United States and still be considered an export. This "deemed export" is treated by ITAR as if a physical export occurred.

So what has happened to make ITAR a serious issue for AMSAT-NA?

In the recent past, AMSAT-NA has been attempting to assist AMSAT-DL with the development of their P3E amateur satellite. Most notably, P3E's integrated housekeeping unit (IHU) function was to use the IHU-3 developed by AMSAT-NA technical volunteers.

When it was realized that amateur satellite development activity could fall under the export control of a document called ITAR, the International Traffic in Arms Regulations, administered by the US Department of State, (and to a lesser extent, the Export Administration Regulations (EAR), administered by the U.S. Department of Commerce), the efforts to support AMSAT-DL ground to a halt as the AMSAT-NA volunteers did not want run afoul of ITAR and its often severe penalties. This then started the spread of what I'll call, "ITAR paranoia" throughout all phases of AMSAT-NA satellite development. Since AMSAT-NA had little or no experience or

guidance to offer in ITAR matters, many volunteers decided to quit working on international AMSAT satellite projects. It became imperative that AMSAT-NA understand these export control rules and provide guidelines for AMSAT-NA volunteer members working on our satellites programs.

Prompted by the concerns of these members and the desire to support the AMSAT-DL P3E project, Rick Hambly, AMSAT-NA Past President, along with others have spent considerable effort for almost two years to understand and work with the constraints demanded by ITAR, develop the appropriate documents and to provide member guidelines. Currently that effort is being lead with renewed vigor by AMSAT-NA's current President, Barry Baines. As Barry reports in his Apogee View, he is working with a well-qualified ITAR attorney to work out the details of what it will take to make AMSAT-NA compliant with the requirements of ITAR.

ITAR Satellite History

Prior to 1992, all items related to military satellite manufacturing were controlled by the State Department as munitions and were subject to ITAR approval. Between 1992 and 1996 debate occurred over who should have jurisdiction over commercial satellites, and after much wrangling, in 1996 commercial satellite jurisdiction was transferred to the Department of Commerce.

Then two launch failures of the China's Long March rocket would once again bring change to US export policy. In January 1995, the failed launch of the Long March 2E rocket carrying Hughes-built Apstar 2 spacecraft and in February 1996, the failed launch of the Long March 3B rocket carrying Space Systems/Loral-built Intelsat 708 spacecraft caused new U.S. Congressional scrutiny on how commercial satellites were exported.

The satellite manufacturers and China worked together to create an analysis of the failure of both these launches. This analysis was required to fulfill insurance requirements and was reviewed by the Department of Commerce. Commerce determined that the export of the analysis to the insurers and China fell under the license Commerce issued in February of 1994 and allowed its transfer to China. This



decision caused a firestorm of political and government interdepartmental squabbling. As a result of what was determined to be severe export violations, Congress in 1999 passed ITAR authority from the Department of Commerce to the Department of State.

In January of 2002, Space Systems/Loral agreed to pay the US government \$20 million to settle the charges of the illegal technology transfer and in March of 2003, Boeing agreed to pay \$32 million for the role of Hughes (which Boeing had acquired in 2000) in the export violation. In addition to that, the company has had the export of its satellite, Chinasat-8, blocked for launch in China from 1998 to the present day.

Effects of ITAR

On the positive side, ITAR has routinely uncovered and prosecuted many violations of ITAR export controls. On the State Department Web site, you'll see the violations are routinely posted. So ITAR is working to prevent the unauthorized export of sensitive munitions and technologies.

On the negative side, there is debate among US commercial and academic satellite builders that ITAR restrictions are stifling U.S. trade and science. They further argue "that ITAR is a significant trade barrier that acts as a substantial negative subsidy, weakening U.S. industries' ability to compete" quoting from http://en.wikipedia.org/wiki/International_Traffic_in_Arms_Regulations. Further "U.S. commercial firms expend significant resources to prove that their products should not be classified as ITAR controlled technology. As a recent example, concerns over connections between the Boeing 787 and the B-2 Spirit stealth bomber prompted Boeing to take elaborate steps cleansing the commercial jet of any military technology. The issue arose when Boeing engineers, fearing indictment and penalties, refused to sign forms declaring that the 787 was 'ITAR-free.' As a result Boeing conducted extensive research on the source of technology implemented on the 787. They removed all military technology and either found a commercial source for the same technology or replaced it with technology derived from a commercial source."

What AMSAT-NA Satellite Items Are Covered Under ITAR

ITAR controls defense items such as satellites and all specifically designed or modified systems or subsystems, components, parts, accessories, attachments, and associated

equipment for satellites as well as many dual-use technologies such as software, integrated circuits, computers, electronics and security-related information systems that are vital for satellites and launch vehicle technologies.

ITAR defines defense items as either "significant military equipment (SME)" or "non-significant military equipment." SME items are obvious. Non-SME items are often unclear and in need of clarifications. Most, but not all, of what AMSAT-NA will do falls under the Non-SME category.

ITAR 121.1 describes "The United States Munitions List." Category IV under this Munitions List, covers LAUNCH VEHICLES, GUIDED MISSILES, BALLISTIC MISSILES, ROCKETS, TORPEDOES, BOMBS AND MINES. Of interest to AMSAT-NA is "Launch Vehicles." Under this category, all specifically designed or modified components, parts, accessories, attachments, and associated equipment for the launch vehicle require export approval. For AMSAT-NA this would include the satellite adapter ring that we would fabricate to bolt the satellite to a launch vehicle. This category also includes any technical or manufacturing data or procedures associated with the adapter ring. While considered a Non-SME item, it still has stringent export rules.

ITAR Category XV of the Munitions List covers SPACECRAFT SYSTEMS AND ASSOCIATED EQUIPMENT

Under this category, our satellites are considered as Non-SME items but still under export controls. Because our satellites or satellites systems in this category are not clearly defined, we must have the Department of State, using their clearly defined procedures, make a determination on a case-by-case basis, and define the requirements for export.

An example could be the proposed export of our IHU-3 or a 70 cm command/transponder receiver along with any detailed design, development, and manufacturing or production data.

Under Category XI—MILITARY ELECTRONICS, computers specifically designed or developed for military application and any computer specifically modified for use with any defense article in any category of the U.S. Munitions List come under ITAR export control. Our IHU-3 could also fall under this category.

What Actions Must AMSAT-NA Take To Comply?

The first thing we must do is not view export control rules, such as ITAR, as the "vile curse" to AMSAT-NA activities. We need to work within the framework defined by ITAR and EAR. Companies do it successfully every day. A good example is Space Quest who supported AMSAT-NA's AO-51 (Echo) and continues to be involved in satellite components and satellites.

Both the Department of Commerce (EAR) and the State Department (ITAR) have clear procedures for working with them and for resolving questions. We have started that dialog by following the procedures they provide.

First, AMSAT-NA is currently registered as a "manufacturer and exporter" with the Department of State – the first step required by State to start any export issue dialog with them. Then there is the use of the "commodity jurisdiction determination" and the "technical assistance agreement."

Commodity Jurisdiction Determination

We can ask the State Department to make a "commodity jurisdiction determination" for the IHU-3 (and any other item we may wish to export). This action by the State Department will identify their view of the potential export status of the IHU-3 to AMSAT-DL.

Clearly, U.S. Munitions list items fall under the ITAR; however, many other items also fall under ITAR that are not specifically listed. If we can show that the product has predominant civilian applications and that it has a performance equivalent to products used predominantly in civilian applications, then we can possibly avoid the more restrictive ITAR determination. However, the State Department has considerable discretion in determining whether a product falls under ITAR.

Technical Assistance Agreement

The next action we might take will be to revisit the drafting of technical assistance agreement (TAA) on the IHU-3 between AMSAT-NA and AMSAT-DL with an attempt to develop a document acceptable to all parties. If this process is successful, it could lay the foundation for TAAs with other AMSAT organizations.

continued on page 28 ...



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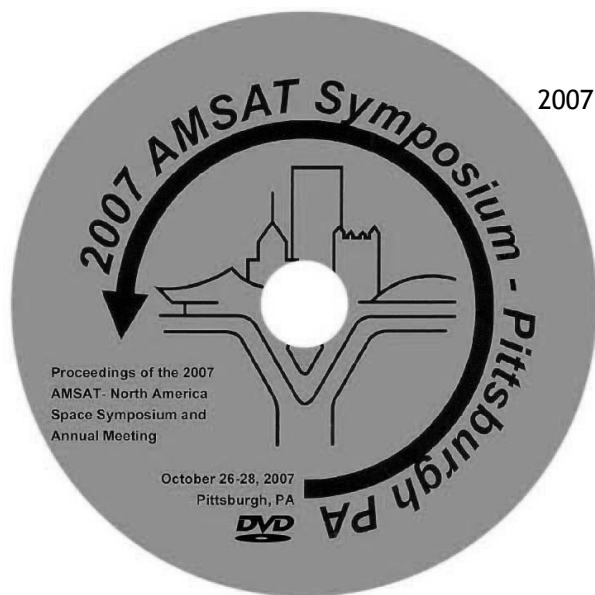
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Chasing Wallpaper Through Space

by Peter Carr, WW3O, wb3bqo@localnet.com

The postman is starting to get an overworked look on his face as he delivers the morning mail. In addition to the usual bills and ads are a collection of small envelopes, all with the same style of printed address label. These are a new bunch of QSL cards.

Notable among these bits of cardboard was one from VA7VW. The card showed both a VW Beetle and a Microbus and was from Ron in British Columbia. He and I had talked one evening on A0-51 when the bird was just about LOS at my QTH. He was standing outside with a portable station in -17 degree weather. I showed my wife the card and she remarked that all hams must be as crazy as me.

Another card that arrived was from Dave, XE3DX, from Mexico. His card was a new grid square for me and so was highly prized. I sat looking at the card and began to realize what Dave had to do to achieve the contact. Mexico surely has a tough ham exam and Dave would also have to have a good handle on the English language to make contacts on voice. Then there was the gathering of equipment and information on how to operate through the birds. Dave had done all that work just so I could receive a small card of conformation of our brief chat. Truly amazing!

Another card arrived from AB3HO in Venetia, PA. There was a black and white picture of Albert Einstein on the front and a quote from him about how radio works. It said, "You see, wire telegraph is a kind of very long cat. You pull his tail in New York and his head is meowing in Los Angeles. Do you understand? And radio works the same way: You send signals here: they receive them there. The only difference is that there is no cat." I've shown that card around at ham club meetings and the reaction is very funny. Some laugh knowingly while others go silent as if storing the information. In any case, the card is a treasure.

Ham operators like to work on earning awards. On the low bands they try for certificates such as Worked All States (WAS) or Worked All Continents (WAC). On satellite there are the VUCC award and the Satellite Communicators Achievement Award. These certificates and Awards are known as wall paper since they are usually framed and hung on the ham shack walls.

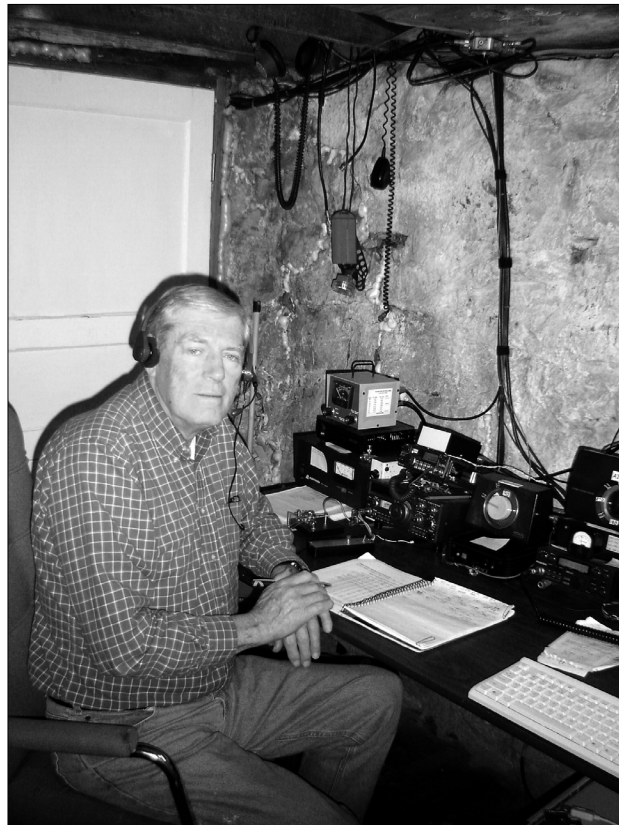
These awards require the gathering of QSL cards as proof of contact.

The cards themselves can be a simple or as intricate as the ham desires. Some reflect station equipment while some are pictures of truly gigantic antenna farms. Others have pictures of family members or their pets. Some are generated by computer, some have been crafted from hand carved block prints and some have very funny cartoons that poke fun at the hobby. The short written messages are a slice of that ham's life on the day of contact and are always fascinating to read.

There are certain sequences and procedures that need to be observed when sending or receiving QSLs. The first one is to be absolutely sure that the entire contact information is correct. Some of us (me for instance) have trouble converting time to GMT especially when it means a change of date. Many hams will print a QSL label directly from their logging program so the info is right. Other, less technically competent hams like myself will hand print the info on a card from a very confusing piece of scratch paper. Addresses are usually

obtained from sources like arrl.org or qth.com and then hand copied onto the card and envelope. For some cards, like the one to Dave, XE3DX, the form of the address is different from those in the States so I have to be extra careful to copy it exactly.

All my domestic cards are accompanied by an SASE. The return envelope makes the job of returning a QSL easier for the ham at the other end. QSLs going out of the USA also have an envelope but no postage. A friendly ham in State College told me that some countries have currency laws so sending along some dollar bills might get a ham in trouble. I use IRCs, International Reply Coupons, which I buy from the local Post Office. I then drop an IRC into the envelope with my QSL and seal it up. Then I buy postage for the trip to the target country. There was another bit of information that I learned from my friend in State College. He said that in some countries the postal people go through the mail looking for money or other types of valuables. If the envelope indicates that ham radio is involved they steal the envelope hoping to find money



Satellite Station 007: I'm Pete, WW3O, in the satellite station. The rigs are a 10 meter all-mode used for downlink with a converter. On uplink it has an upconverter plus a 40 watt brick. The two meter rig is a Yaesu FT-290R all-mode. Antennas are a 5 element 2meter and 10 x 10 element 70 cm both by Cushcraft. A Kenwood TS-130 HF rig is on the left side of the table.



inside. I don't show any callsigns on the outside of the envelope for that reason.

It was 30+ years ago when I achieved WAS. At the time I thought that the miserable audio and interference was all part of the game. Now, with the terrific radios and VHF/UHF frequencies, the audio quality is like being in the same room with the ham contact. Still, there are occasions where crowding, such as encountered on AO-51, can cover part of the contact information. Using phonetics is a help, but sometimes can cause confusion if non-standard words are used. On VO-52, which is a SSB satellite, operators are always fighting the Doppler shift so it's not unusual to miss part of a callsign while tuning. Fortunately, the operators I've worked are all very skilled and understanding. Compared to HF back in the day, chasing contacts via satellite is a walk in the park.

If you want to work toward an award the best plan is to be sure that you understand the rules. For example, The Satellite Communicators Achievement Award requires that you send copies of the QSL cards to a special Awards Manager who is an AMSAT volunteer. You need to follow the procedure as written or risk being rejected. There is also a charge for the cost of the certificate and the type of payment is spelled out. This should also be followed closely to ease the work at the managers end.

My QTH is located where there is a mountain just to the south. This blocks all but the highest elevation passes of satellites to the south. If I wanted to work into Central or South America it would be nearly impossible at first look. However, as a very average pool player I've learned to overcome blockages like that. I print out the satellite passes from the amsat.org Web site. This gives me the azimuth and elevation data to determine when the bird will be visible at my station and also where I want to talk. Many of these passes are quite low in my horizon. For instance the contact with Dave, XE3DX, was made when AO-51 was out over the Mississippi River and headed north. I could see the bird around the side of the mountain while it was a clear shot into Mexico. Similarly, Ron, VA7VW, was just on the edge of the birds' coverage and nearly LOS at my station. The window of opportunity was brief and my hat is off to Ron for his copy of my noisy signal. The AMSAT pass printouts are an essential tool in helping to bag the tough ones.

There is still a lot of empty space on the shack walls. I hope to fill in these spots with notable QSLs and awards as the adventure of satellite ham radio continues.

Resources

http://www.dxzone.com/catalog/DX_Resources/QSLing/

http://www.dxzone.com/catalog/DX_Resources/Ham_Radio_Awards/

www.arrl.org/awards/vucc/vuccrule1a.pdf



AMSAT SKN on OSCAR

Many thanks to all who participated in AMSAT's Straight Key Night on OSCAR 2009. Thanks in large part to the popularity of AO-51, we have a record 24 Best Fist winners this year. Participation outside North America was especially high, especially in Asia, a trend which we hope will continue.

The following amateurs each received at least one Best Fist nomination from someone they worked:

AA5PK, I6IBE, JA1COU, JA0CAW, JE4QGF, JG5WLV, JM1LRA, JN1UEP/4, JO3MQY, JR0EFE, K8DID, K9QHO, K0RJS, KN4OK, N3TL, N4ZQ, N5AFV, N7EQF, W6ASL, WA6ARA, WA8HOK, WA8SME, 9A5YY, 9M6YBG

See you next year!

73,

Ray, W2RS, rsoifer@aol.com

with ITAR, and 3) request guidance from the State Department regarding our desire to work with AMSAT-DL and AMSAT-UK on Phase 3-E. Frank was in DC over the inauguration weekend (17 Jan 09) and met with Tom Clark, K3IO; Dick Daniels, W4PUJ; Frank Bauer, KA3HDO; and AMSAT Manager Martha Saragovitz. We expect that by the end of March we will have submitted the necessary paperwork to brief the US State Department on AMSAT's past and current activities and lay the groundwork for discussion with the State Department regarding future AMSAT cooperation with AMSAT-DL and AMSAT-UK.

AMSAT Lab

We're continuing to look for a new home for the AMSAT Lab. Discussions are continuing with several potential host locations and I am hopeful that we will indeed be able to find a new home that will allow AMSAT to enhance both its satellite integration capabilities as well as expand our educational outreach. Despite the difficult economic situation, prospects are good that we'll be able to reach agreement later this year with a host institution. In the meantime, we continue to work with our attorney in Pocomoke, MD to work out an arrangement with the Hawk Institute for Space Sciences (HISS) to allow AMSAT to remove its clean room, test equipment and associated items from their facility. We intend to place this equipment in storage until we have created a new facility.

AMSAT Donations

Thanks to the generosity of a number of individuals, AMSAT received almost \$36,650 in donations in December 2008 and early January 2009 in response to our year-end appeal for the President's Club. We appreciate the generosity of those that support AMSAT during this difficult time. Clearly, this funding will provide seed money for future satellite development. Given that we are currently 'on hold' regarding Eagle, this expression of support is appreciated.

As always, I look forward to hearing from our membership. I attended the Orlando Hamcation in February and will attend the Dayton Hamvention in May. As time permits, I'll be attending other hamfests as well. Please drop by the AMSAT booth and say hello.

73,

Barry, WD4ASW

AMSAT President



But even if there is a TAA in place, there are subsequent documentation and reporting rules regarding administration of the TAA that can be just as onerous as the basic tenant of ITAR. This includes documenting/logging all foreign communications (voice communications, e-mails, file transfers, etc.), maintaining visitor logs at locations where work is being done (e.g. the basement where the IHU-3 is being tested), etc. Prosecution can occur for failure to maintain proper administrative procedures as well as the inadvertent violation of transferring technical information. The potential implications of administering ITAR are something that AMSAT-NA will need to address.

Our basic dilemma with TAA's is that the basis for this document places the foreign nationals under US law. That is, the TAA places the same restrictions on the foreign nationals for subsequent responsibility for limiting distribution of information that they receive under the TAA as US citizens. For example, if the IHU-3 were to be subsequently provided by AMSAT-DL to another AMSAT organization that does not have a TAA with AMSAT-NA, then the volunteers within AMSAT-DL could be subject to US criminal prosecution.

AMSAT Compliance Guideline

AMSAT-NA will then continue work on a formal "AMSAT-NA ITAR/EAR Compliance Guideline" to be made available to all AMSAT-NA volunteer members working on joint international satellite programs. It is planned to be a do's and don'ts document for our volunteers.

Conclusion

One can argue that ITAR has caused countries that were once our space industry's customers to develop their own space/satellite industry. Some say were losing our technical edge in space to the newly forming foreign competition. But whatever complaints one puts forth about export control rules such as ITAR and EAR, the simple fact is they are here, they can apply to us and they must be adhered to. Understanding, following and working within the export control rules must be an on going activity for AMSAT-NA if we are to continue our joint satellite development efforts with other AMSAT organizations.

Footnote

- [1] U.S. State Department – Directorate of Defense Trade Controls – ITAR
http://www.pmddtc.state.gov/regulations_laws/itar_official.html 

RF Amplifiers

A High Efficiency, Broadband GaN Amplifier for Amateur Radio

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Abstract

This paper presents the design and application of a highly efficient, broadband amplifier capable of producing more than 20W over nearly a decade of bandwidth. Simple design techniques as well as freeware software is referenced to keep this amplifier well within the capabilities of the radio amateur.

I. Background

In the design of High Power Amplifiers, HPAs, we are constantly evaluating new RF devices. Many of these devices produce between 50 and 100W per transistor with gains that vary from 10 to 20dB. Because common RF laboratory test equipment signal sources have output power capability that is usually limited to 100 to 200mW, there is always a need to have a dependable driver amplifier to be able to characterize the output power of the device under test. When evaluating a variety of devices covering a wide frequency range from 50 MHz to 500 MHz this typically required the use of several different driver amplifiers, each tuned for the specific band of interest. Thus, it is desired to have a broad band amplifier capable of covering this entire range. This allows us to test higher power amplifiers that cover the Amateur Radio 6 m, 2 m, 1.25 m and 70 cm bands without changing the test setup of the driver amplifier. Thus the original goal of this work was to design an amplifier that could produce 20W with >15dB gain and cover the 50 MHz to 500 MHz frequency range.

II. GaN Technology

A new RF device technology that is emerging is Gallium Nitride, GaN. Presently there are a few companies producing high electron mobility transistors, HEMTs, using Gallium Nitride technology. These include: Eudyna, RFHIC and Cree. Gallium Nitride technology is of particular interest to the amplifier design community because of the following properties:

- high power density
- high breakdown voltage
- high operating temperature
- high input impedance
- high efficiency

These characteristics make GaN HEMTs a natural for the requirements of the broad band driver amplifier. The device chosen for this amplifier is the EGN045MK by Eudyna.

III. Amateur Radio Applications

An amplifier covering an instantaneous bandwidth from 50 MHz to 500 MHz is of obvious interest in Amateur Radio applications. A highly efficient amplifier is of particular interest because many radio applications are battery operated. One such application is the operation of FM low earth orbiting satellites such as AO51 and AO27.

Operating AO51 and AO27 with 5W handheld transceivers can be a challenge in the mountains of southwestern Pennsylvania where there is persistent foliage attenuation of VHF and UHF radio waves. Having 3dB to 6dB higher output power can make a significant improvement when uplinking to these satellites. The remainder of this paper will describe the design, test results, and LEO operation of the amplifier. A design goal of 20W with an efficiency >50% over the entire 50 MHz to 500 MHz bandwidth has been established.

IV. High Efficiency Amplification

In recent years there has been much written on the subject of high efficiency amplification. Much of this work is grounded in low conduction amplification modes such as class D, E, and F. In these modes the transistor is biased at or near cutoff so that the conduction angle is minimized. These are all variations of switch mode amplifiers that require precisely tuned circuits or harmonic terminations for proper operation. As a result they do not lend themselves readily to broad band operation. An often-overlooked high efficiency amplification mode is the overdriven class A amplifier [1].

The class A amplifier is better suited for broad band operation due to the longer conduction angle and resulting load impedance. Class A bias is also more useful for using the amplifier as a driver amplifier for higher power device testing. When the class A amplifier is driven into saturation, the output waveform is clipped thus decreasing the



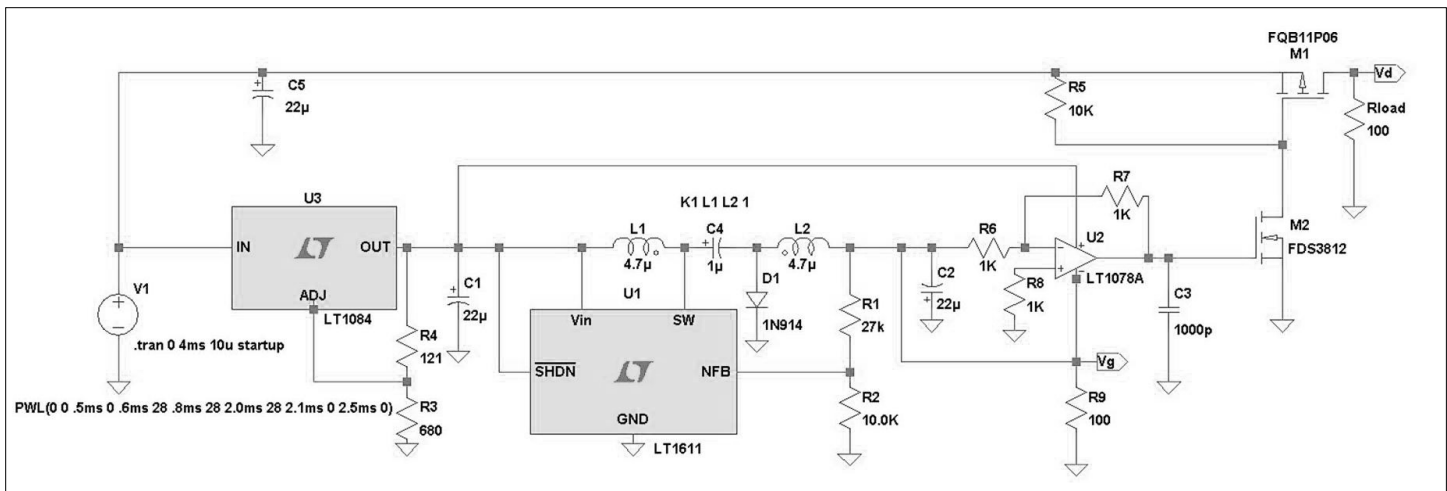


Figure 1: Spice model of bias circuit in LTspice/SwitcherCAD III.

conduction angle which results in higher efficiency. Due to the high breakdown voltage and robust nature of the GaN HEMT, saturated class A operation is possible.

V. Amplifier Design Tools

The amplifier design is divided into two parts: RF Design and Bias Circuit design. To encourage participation of radio amateurs and in keeping with the educational theme of the 2007 AMSAT symposium, two freeware software programs are used to complete the design of the amplifier. The student version of Ansoft Corporation's 'RF Designer SV' software was used to simulate the RF design portion of the amplifier. This software can be downloaded from Ansoft's Web site: <http://www.ansoft.com>. The bias circuitry was designed using Spice. An excellent freeware

version of Spice is LTspice/SwitcherCAD III available from Linear Technology Corp. It is available for download from their Web site: <http://www.linear.com>. These two programs were particularly helpful in that they were able to show the effect of substituting one part for another before actually making the substitution. In addition to these two programs, the 2007 student version of Matlab was used in preparing the plots of output power and efficiency.

VI. Bias Circuit Design

The amplifier is intended to operate from a single 28 VDC power supply. A highly efficient amplifier can mean that a common 28 VDC wall-wart style power supply can be used to power the amplifier. Thus the drain of the HEMT will be connected to the 28 VDC source. The gate of the HEMT must be biased negative with respect to the source. The source of most RF power HEMTs are flanged and therefore connected to DC ground. Therefore a negative voltage must be generated to operate the device. The Linear Technology LT1611 was chosen as the DC/DC converter to generate the negative gate voltage. This device generates a regulated negative voltage and up to 150mA with minimal external components. The GaN HEMT will draw negligible current from the negative supply under small signal (< 50mW) drive conditions. However when the amplifier is saturated the HEMT can draw over 10mA of gate current. Therefore a voltage divider will set the gate voltage close to -1V and allow a bleed current of 10mA. An MC7808 8V regulator is used to step the +28 VDC input supply down to a usable input voltage to the LT1611.

As with any GaAs or GaN device, it is important to set the negative voltage to the

gate before applying the +28 V to the drain. It is very important to properly sequence the gate and drain voltages to avoid damaging the device. A P-channel MOSFET is used as a switch for the +28 V to the drain. The output from the LT1611 is used to turn the MOSFET switch on and off. This is where a good Spice model is required to ensure proper sequencing of the gate and drain supply voltages. Figure 1 shows the Bias Circuit schematic.

Figure 2 shows the gate and drain voltages from startup of the +28 V supply. As shown the gate voltage is stable before the +28 V drain voltage ramps up. When the input voltage is turned off, the gate voltage slowly decays over 1.5 msec. The bias circuit board is built on FR4 circuit board material and will be mounted adjacent to the RF amplifier board.

VII. RF Circuit Design

Because this amplifier is intended for small signal as well as large signal operation, the device is biased in the class AB region. This allows us to use small signal S-Parameters as a starting point for the RF circuit design. First the S-Parameters are analyzed for stability. To stabilize the device for operation in the VHF-UHF frequency range, a 5 ohm resistor is added in series with the device input. Also an RC feedback circuit has been added to guarantee that the stability factors K and B1 are satisfied [2]. A four-section low pass network is used to match the input and output of the device for maximum gain and good return loss over the 50 MHz to 500 MHz bandwidth. Figure 3 shows the initial schematic in Ansoft Designer SV. The block labeled 'EGN045MK' is a data file that contains the S-Parameters for the GaN HEMT device. The input and output

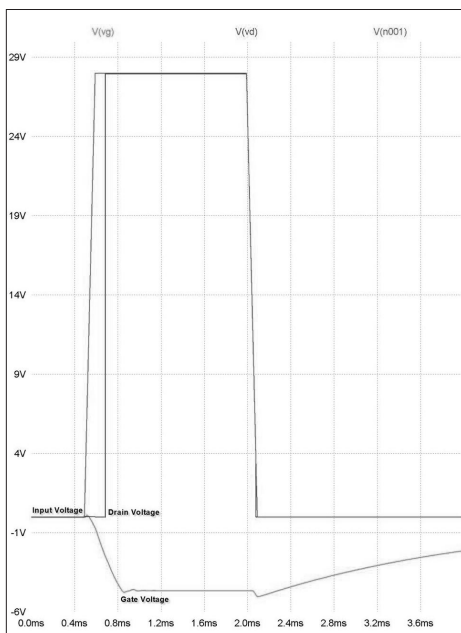


Figure 2: Timing diagram for bias sequencing circuit showing relationship among the 28 VDC input voltage, output voltage and negative gate voltage.

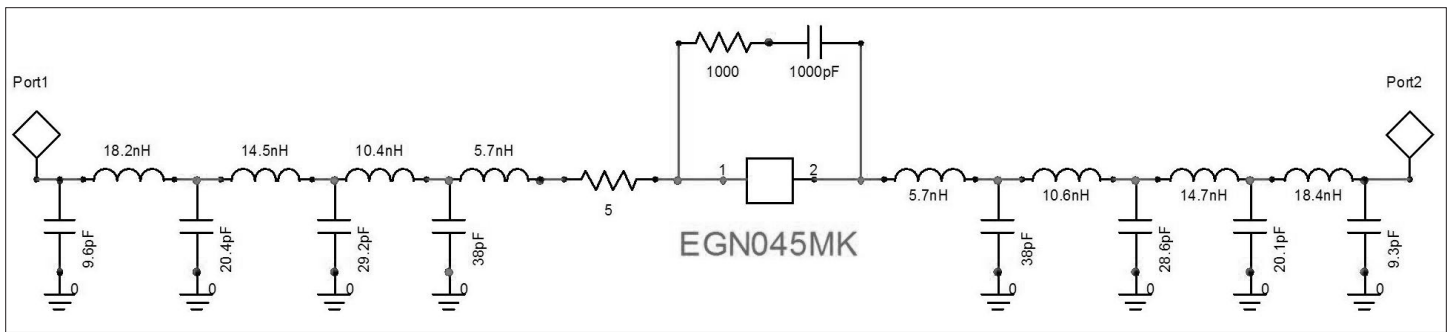


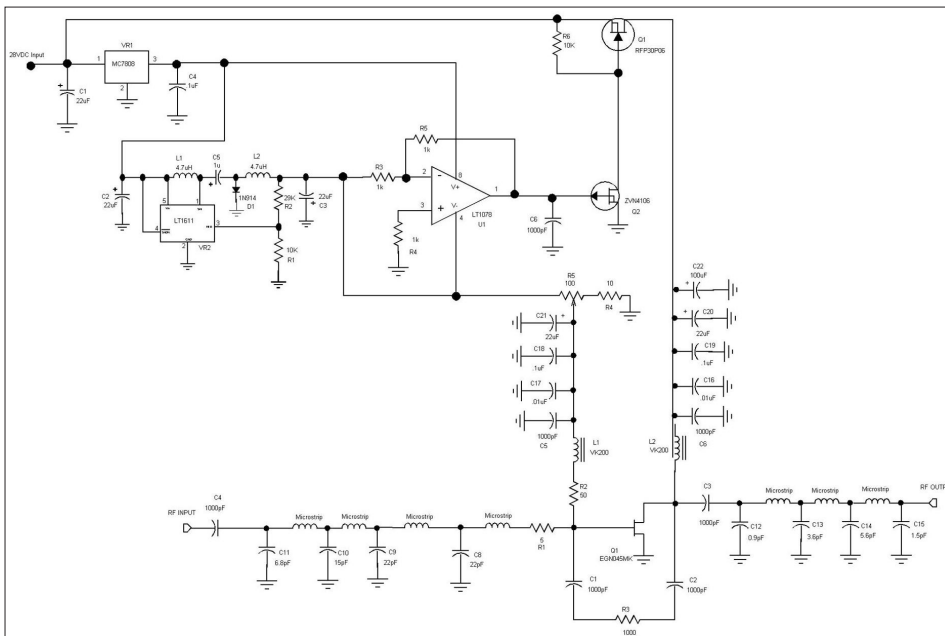
Figure 3: Schematic prepared for linear simulation in Ansoft Designer SV.

matching elements can be tuned to observe their effect on the gain and VSWR before the circuit is built. The amplifier circuit is designed on Rogers RO4003 substrate material. This substrate was chosen for its good RF characteristics and ease of processing. To simplify the assembly, all of the series inductors were replaced with high impedance (70 ohm) transmission lines to

and operation mode of the amplifier.

VIII. Measured Performance

The gate voltage was adjusted to approximately -1.1 V which resulted in a drain current of 600mA. This puts the device well within the class AB bias range. The small signal gain vs frequency was evaluated on a scalar network analyzer.



4: Complete broadband amplifier schematic.

effectively distribute their inductance over a length of high impedance transmission line. The capacitors used are made by Dielectric Laboratories (C17CF series). The complete schematic of the amplifier is shown in Figure 4. Note the use of the VK200 ferrite core to feed the gate and drain bias voltages to the device. The VK200 presents a resonance free, broadband choke to the device for stable operation. A series of decoupling capacitors are also provided on each bias feed that provide a proper broadband shunt. A 100 ohm potentiometer is used on the gate circuit so that the gate bias can be tweaked for a particular quiescent point. This allows experimentation with the conduction angle

As Figure 5 shows, only minor tuning was performed on a couple of the inductive transmission line sections to improve the gain above 400 MHz. The final measured gain is shown in Figure 6. As the figure shows, the measured response is very close to the simulated circuit. The output power and drain current were then measured to evaluate the overall efficiency of this amplifier. The amplifier was evaluated in each of the four amateur bands: 50 MHz, 146 MHz, 222 MHz, and 440 MHz. The output power and efficiency is summarized in Table 1.

IX. AO-51 Operation

In FM communication systems, operation

of the power amplifier in saturated mode is possible. Saturated operation of the amplifier would not be acceptable in AM or Single Sideband due to the distortion caused by intermodulation products. Dual-band, hand-held transceivers such as the Kenwood TH-D7A can be operated in full duplex mode for satellite operation. Because of the excellent efficiency and single ended supply operation, it is possible to power the amplifier for portable operation. Operation with a portable, split boom antenna such as the Arrow II can experience receiver desense. This is due to the higher output power from the HPA and minimal isolation between the VHF and UHF antennas. To overcome this it is helpful to install a VHF low pass filter on the output of the HPA and a UHF high pass filter on the input to the receiver. The VHF low pass filters serves to reduce the transmit output noise power density in the UHF downlink band. This filter is also helpful for reducing harmonic energy from the HPA. The UHF high pass filter further reduces the HPA output noise coming through the UHF antenna. A duplexer is used to combine the uplink and downlink bands to a single feed for connection to the TH-D7 handheld transceiver. The duplexer will provide an additional degree of filtering of the VHF output signal from the UHF input. The filters are mounted to a bracket behind the antenna handle. The HPA and power supply are mounted to a tripod. The antenna can also be mounted on the tripod via a ball socket that allows full azimuth and elevation movement of the antenna. Using the TH-D7A at its 'low power' setting presents a good drive level for the HPA.

X. Filter Design

Fortunately the Ansoft Designer SV program includes a filter design tool. This greatly simplifies the design of the VHF low pass and UHF high pass filters. A fifth order Chebyshev topology was chosen for the VHF filter with a cutoff frequency of 150 MHz.

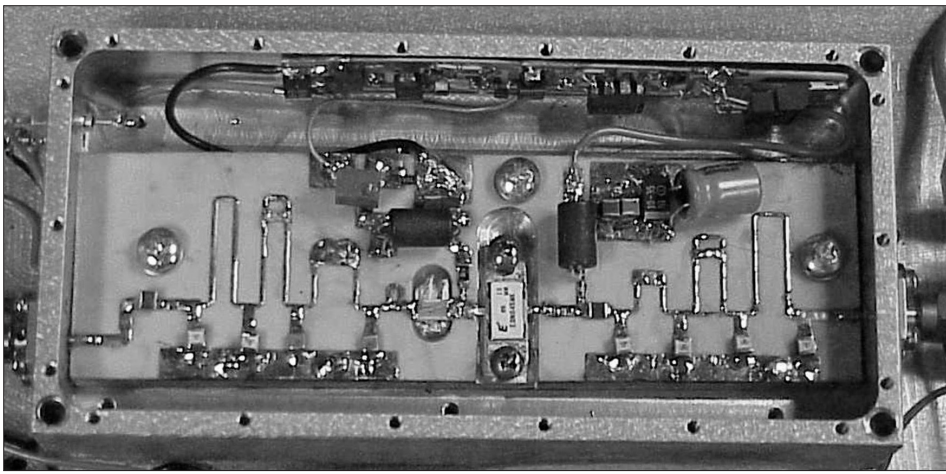


Figure 5: Assembled broadband amplifier with bias board mounted on side wall.

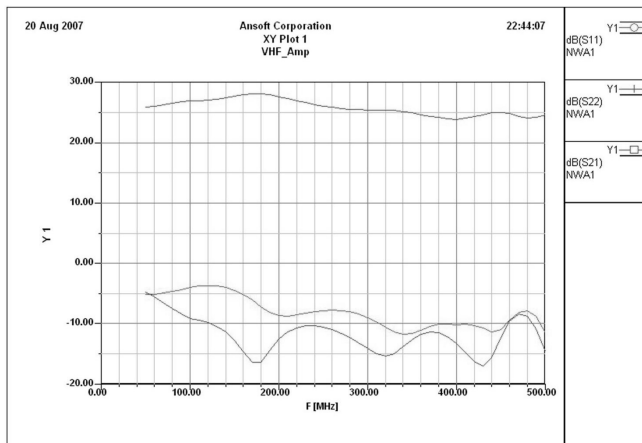


Figure 6: Simulated gain (S21), input return loss (S11) and output return loss (S22).

Air wound inductors were homebrewed with .050 inch diameter bus wire while chip caps were used for the shunt capacitors. The filter was built on the same RO4003 substrate as the HPA and fitted with solder-on SMA connectors.

A seventh order Chebyshev topology was chosen for the UHF high pass filter with a cutoff frequency of 400 MHz. This

filter was built on .030 inch thick Duroid substrate on an aluminum carrier. The carrier was fitted with flange mount SMA connectors.

XI. Summary

A broadband VHF/UHF amplifier has been presented. The amplifier has successfully achieved nearly a decade of instantaneous bandwidth. Biased for linear operation and having 20dB gain and 20W output power capability makes this amplifier an ideal driver amplifier for the RF lab. This amplifier will be used to assist in the test and evaluation of much higher power devices.

The amplifier has also been demonstrated to be an effective 20W amplifier for VHF/UHF dual band handhelds with 1W output capability. We have successfully made several AO-51 contacts using the amplifier.

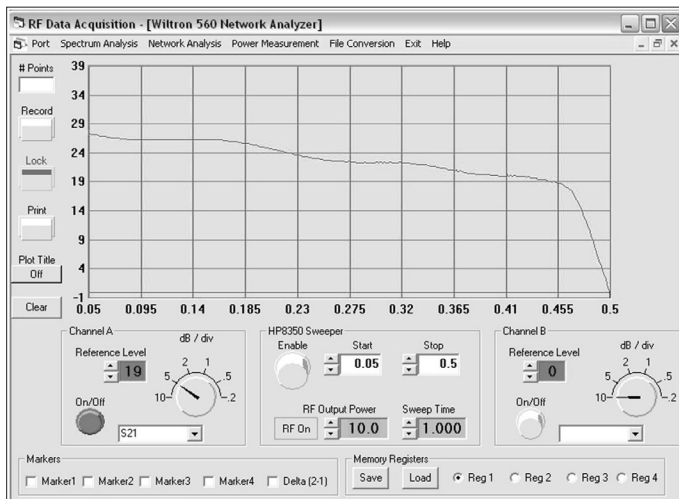


Figure 7: Measured small signal gain vs frequency in GHz.

Freeware and low cost software was used throughout the design process to encourage students and Amateur Radio operators to participate in RF circuit design.

Using a GaN HEMT device along with overdriven (saturated) operation makes this amplifier suitable for FM radio operation. It should be emphasized that this amplifier has

been designed for linear operation using small signal design techniques. No particular effort was made to load match the device for high efficiency. Reasonably good drain efficiencies have been achieved without the use of a higher class bias setting, harmonic terminations or large signal output matching. Despite this, the efficiencies presented are comparable to much of the published efficiencies of class D, E, and F power amplifiers. This shows the promise of GaN technology in the realization of high efficiency amplifier design.

Future work will focus on optimizing the efficiency and linear operation for AM and SSB applications.

References

- [1] Steve C. Cripps, "RF Power Amplifiers for Wireless Communications," Artech House, 2006
- [2] "The ARRL UHF/Microwave Experimenter's Manual," Chapter 6, 1990

About the Authors

Stephen Turner is a long time Amateur Radio operator with particular interest in operation above 50 MHz. He holds an Extra Class license and is a member of AMSAT, ARRL and QCWA. He is presently the VP of Engineering at Paradise Datacom, focusing on the design and manufacture of high power amplifiers from S band through Ka band.

Charles Turner is an undergraduate student at the University of Pittsburgh's Department of Electrical and Computer Engineering. Charles presently holds a General Class Amateur Radio license and is a member of the ARRL. 

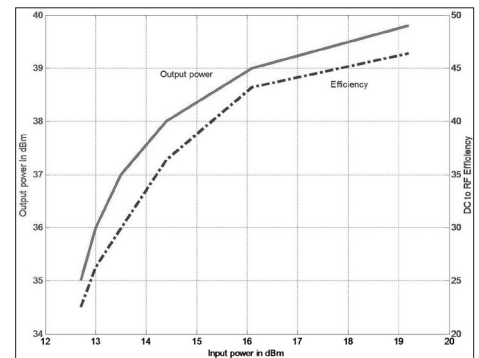


Figure 8: Output power and efficiency at 50 MHz.

Figures continue on next page ...



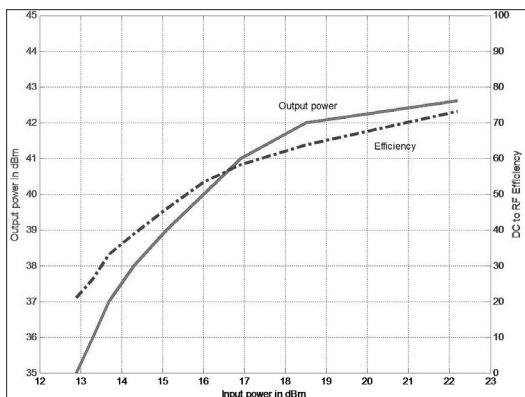


Figure 9: Output power and efficiency at 146 MHz.

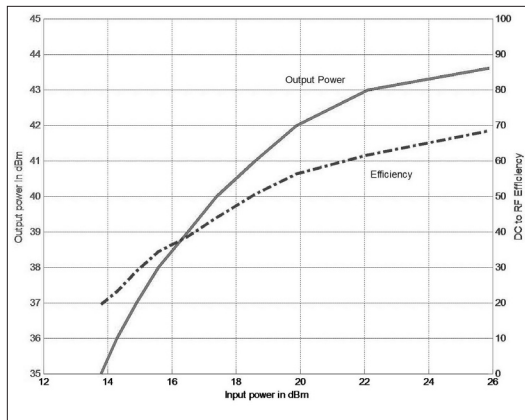


Figure 10: Output power and efficiency at 220 MHz.

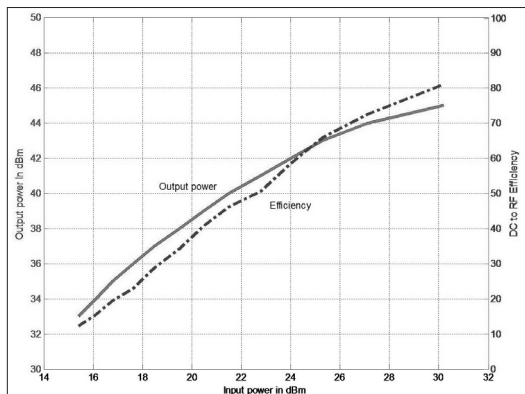


Figure 11: Output power and efficiency at 440 MHz.

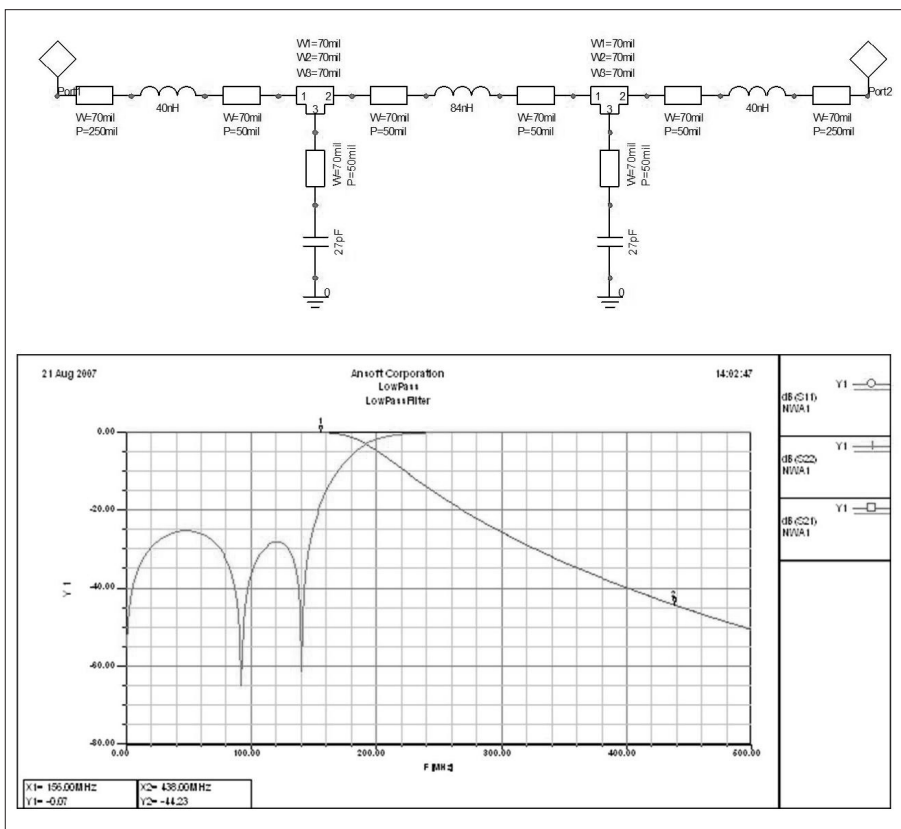


Figure 13: VHF low pass filter schematic and simulated response.

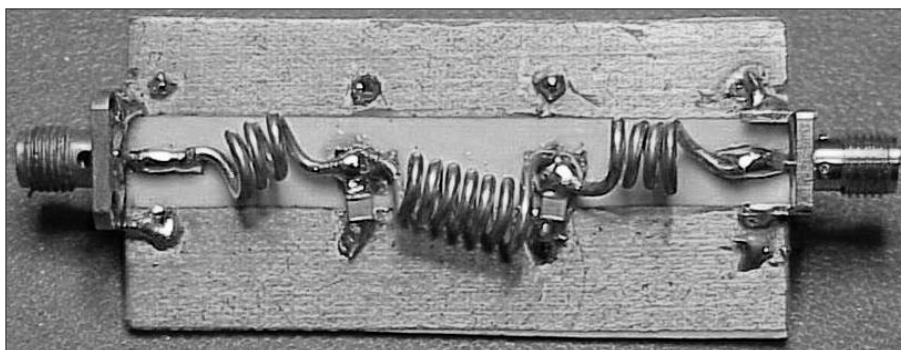


Figure 14: Assembled VHF low pass filter.

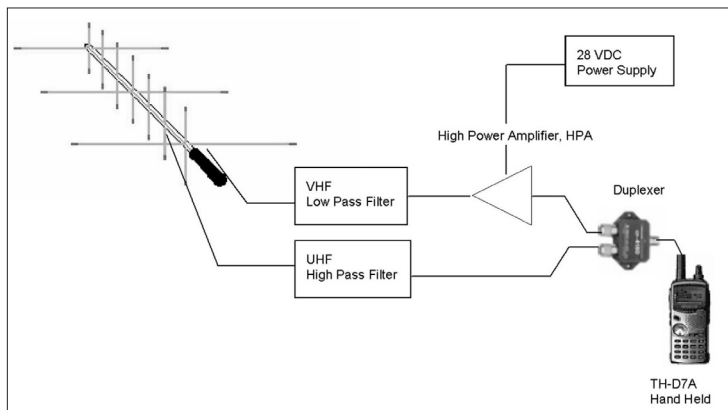


Figure 12: AO-51 station configuration.

Table 1. Saturated Output Power and Efficiency Summary				
Frequency	Psat, dBm	Psat, Watts	Drain Current @ 27 VDC	DC-RF Efficiency
50 MHz	39.8	9.55	.76	46.4
146 MHz	43.0	19.95	1.00	73.8
222 MHz	43.6	22.91	1.24	68.3
440 MHz	45.0	31.62	1.44	81.2

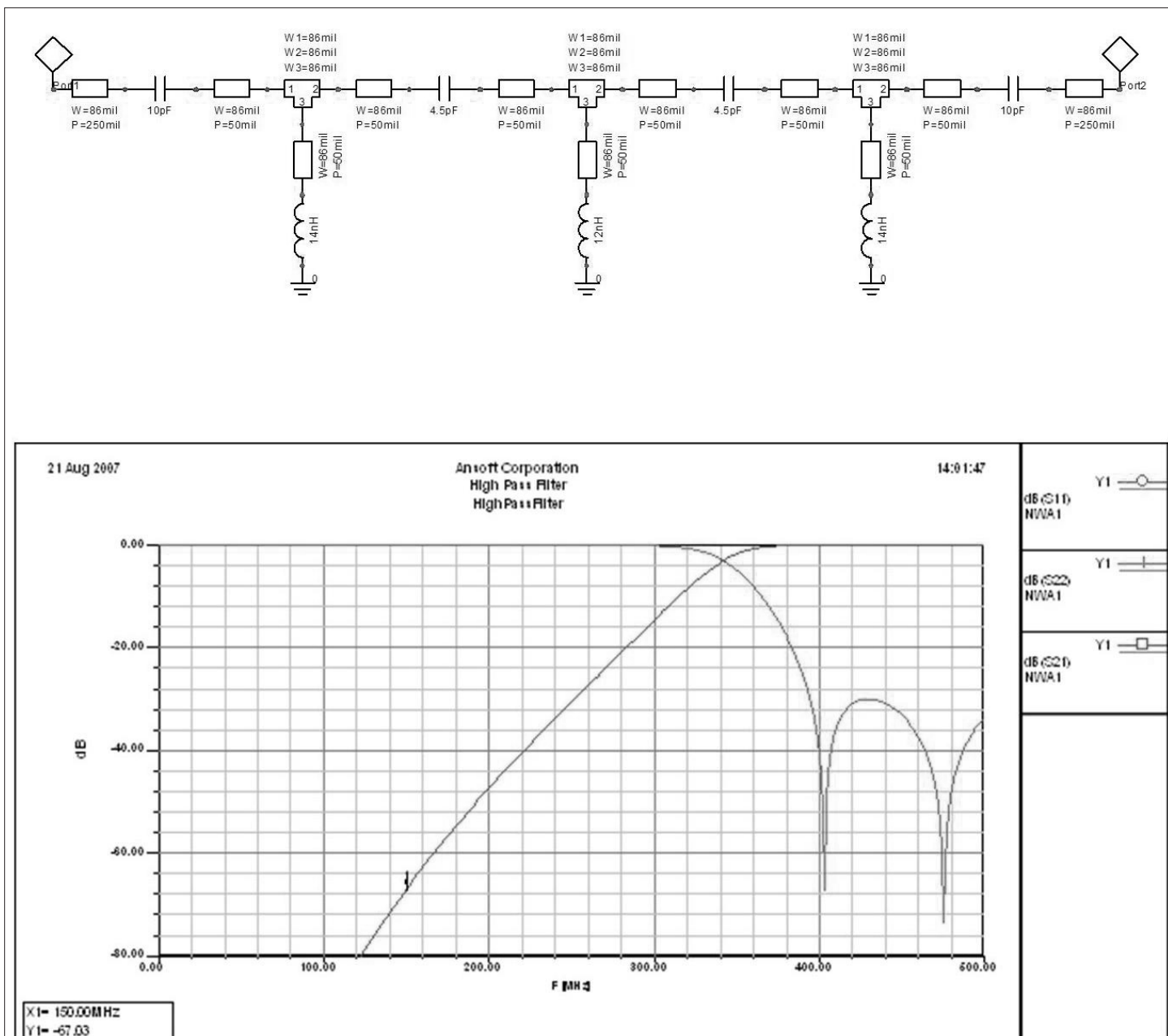


Figure 15: UHF high pass filter schematic and simulated response.

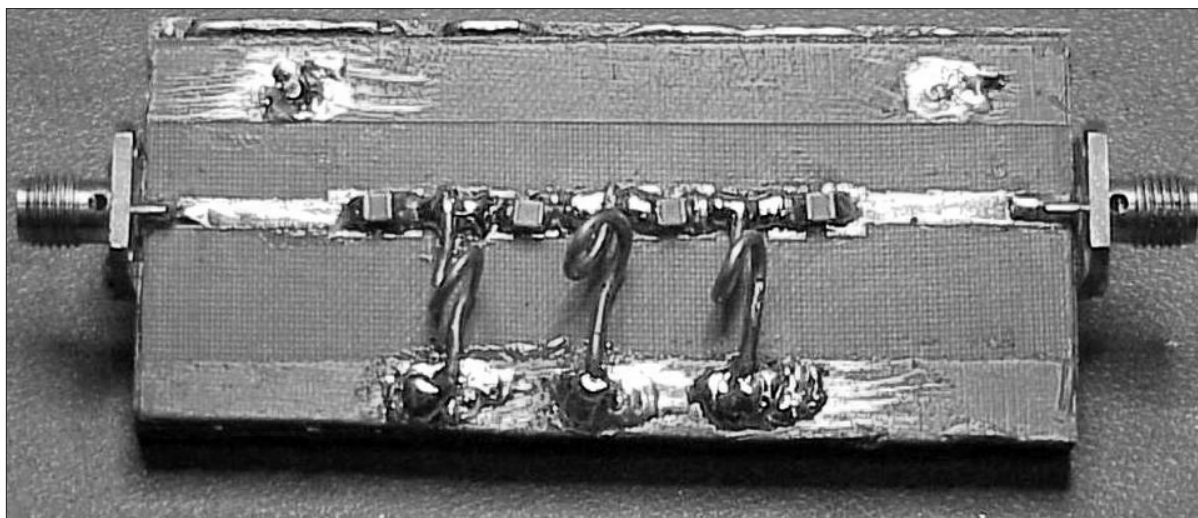


Figure 16: Assembled UHF high pass filter.

Teachers Institute II, Using Satellite Telemetry in the Classroom

Mark Spencer, WA8SME, mspencer@arrl.org

ARRL Education and Technology Program Coordinator

The ARRL is fortunate to be able to sponsor the Education and Technology Program (ETP), which is a philanthropic supported grant program that encourages schools to integrate wireless technology literacy, the science of radio and basic electronics in their curricula. The ETP offers a portfolio of grant opportunities from full-up ham radio stations for schools, to curriculum resources, to a teacher in-service training opportunity called the Teachers Institute (TI).

The content of the TI includes the science of radio, bringing space technology into the classroom, microcontroller basics and basic robotics. This curriculum is broad based and easily fills the 4-8 hour days allotted to the TI curriculum. The intention is to stimulate ideas among the teacher participants for the use of these content areas in their school's curriculum once they return to their regular classroom as well as provide them with the resources required for the additional self-study needed to become literate enough in the content areas so that they are able to more effectively teach the content. The TI has been arguably very successful, but the TI participants have consistently asked for additional in-service training opportunities that build upon the initial 4-day in-service of the TI.

Consequently a teacher's institute follow-on curriculum has been developed and will be piloted this summer with an inaugural core of six teachers selected from TI graduates. This course is called TI-II (2). The TI-II will be more focused in content so that the material is covered in greater depth than breath. There will be more stringent qualifications to attend the TI-II and likewise higher post TI-II expectations of the participants.

The TI-II Inaugural Curriculum

The focal topic of the TI-II is bringing space into the classroom and will build on the brief introduction of the content that is included in the basic TI curriculum. The specific content includes setting up a satellite ground station including antenna rotor system, tracking software, and interface; the set-up and operation of the receiving system; set-up and use of computer display software. And then the participants will use their stations to receive and exploit Morse code transmitted telemetry from available satellite resources.

The first day would be dedicated to the setting up and learning how to use the station and components, the second day would be dedicated to using the station to work with selected satellites, capturing and interpreting telemetry data.

The TI-II will concentrate on receiving and exploiting satellite telemetry that is transmitted by the various CubeSats and the NOAA weather satellites. Current plans include using CO-55, CO-57, CO-58, LO-10, FO-29, RS-22 and RS-30. The CubeSat telemetry that is sent via CW is used because of the simplicity of the system required to receive the telemetry. The participants will learn how to manually manipulate the data as well as use freeware or Excel based software to use computer technology to interpret the telemetry. The NOAA weather satellite curriculum would simply be an expansion of the current curriculum used in the TI with the participants actually setting up a station and receiving their own imagery on that station. Time will also be spent on AO-51 to make some voice contacts using their ground stations and personal HTs.

Each participant in the TI-II will receive a basic satellite ground station that they will take home to use in their classrooms. The station resources include a G5500 AZ/EL rotor and computer interface, an Arrow antenna, interconnecting cables and connectors, Yaesu VR5000 all mode receiver, tracking software and some ancillary text materials. The total equipment value that each participant will receive is approximately \$1300. Additionally the travel and lodging expenses for each participant are covered at approximately

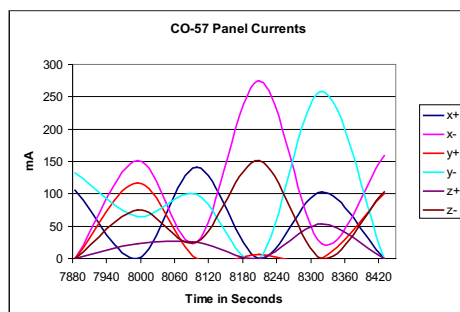
\$1200. All the costs of the program are covered by the generous donations to the ETP. All that is asked of the participants is their time and motivation to use the materials in their classrooms.

Beyond the higher level of expectations to be invited to the TI-II, the participants will be expected to develop two lesson plans focused on using the space technology in the classroom for publication and distribution. They also will be required to write a feature article about their experiences in using the material in the classroom for submission and possible publication in *QST*, *CQ-VHF* and/or *The AMSAT Journal*.

The TI-II will serve as a model for other future TI graduate level courses for teachers that will focus on other topics that might include 1. more basic electronics and the use of test equipment, building and testing circuits, etc., 2. ham radio operation on the various modes including PSK31 and other digital modes, station set-up, building station components particularly the construction and tune-up of antennas, and 3. more advanced programming techniques using the BStamp and the BOE-BOT.

My personal hope and goal is that this first TI-II curriculum serve as a model of the type of curriculum that could be offered to school teachers preparing for ARISS contacts. Modified background material and the practical application of satellite ground station set-up and operation of the station experienced during the TI-II would better prepare these teachers to get the most out of the rare and valuable ARISS contact resource, and give them the information and resources they need to continue the use of space in their classrooms long after the ARISS contact is done.

If you have questions about the ARRL ETP or how to get your local school and teacher involved in the program, check out the information on the ARRL Web site or contact me at mspencer@arrl.org. Hope to see you on the birds. (By the way, I still need to get confirmed contacts with MA and NH for my WAS Satellite.) ☺



Typical CW telemetry data plot. Step 1, track the satellite; 2. receive and collect the data; 3. translate the data; 4. graph the data; 5. most important: "What is the data telling us?"



SuitSat-2 Meeting Gould Smith, WA4SXM, wa4sxm@amsat.org

SuitSat-2 team members were hosted by the Microchip team at the Microchip complex in Phoenix Friday February 20 through Sunday Feb 22, 2009. This was a working and planning session where everyone came away feeling quite a bit was accomplished. Some of the team members came on Friday and worked late into the night discussing interfaces and writing software. Saturday morning Frank Bauer went over the ARISS structure and how this project fits into the ARISS mission. Frank explained that we need to deliver flight ready hardware by September 2009 to match the availability of an Orlan suit in which to put the SuitSat-2 electronics.

Representatives from all of the module teams gave short status reports, all showing good progress. The modular system was well thought out and we are now integrating the modules into a working system. (See Figure 1.) Most of the modules are operational and many were demonstrated during the meeting.

- Antenna – complete
- Video hardware – operational
- RF – (TX and RX) in development
- Safety box – developed and being reviewed
- Solar panels – complete as a flexible panel
- Battery – new battery available
- Enclosures – designed and being milled
- Experiments – development and simulator boards done
- IHU Stack – hardware operational and software being written
- Command receiver – in design
- Cables – designed and being built

Steve Bible, Joe Julicher and Jerry Zdenek demonstrated a new, operational 'IHU Stack' to the group (see Photo 1). The stack has the Interconnect Board (ICB) with debug on the bottom, the Power Supply Unit (PSU) above the ICB, the Integrated Housekeeping Unit (IHU) the board with the debug LEDs illuminated in the figure and the Software Defined Transponder (SDX) board on the top. The command receiver board will be added to the ICB on the side of the stack. Jim Johns, Bill Reed and Tony Monteiro (via teleconference) of the SDX group worked with Joe Julicher refining the IHU-SDX communications and data exchange

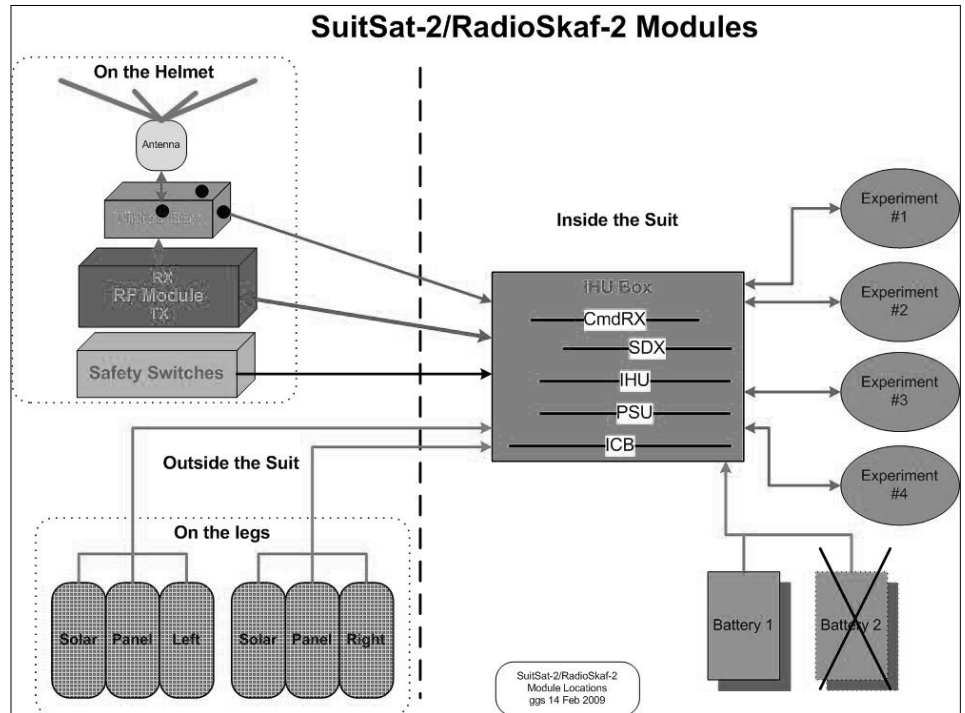


Figure 1: SuitSat-2 modules.

during the scheduled work sessions and into the night all three days.

John Charais had the first fully populated PSU board on hand and talked about his PowerPoint converter circuit. Tim Moffat had hand soldered over 400 SMD parts on this board. Stephen Porter demonstrated the new software available for the IHU Experiment simulation board and for the sample experiment development board.

Currently we have two experimental slots available if you know of a school or university group that might want to develop a simple experiment. The basic guidelines for the experiments are 1) experiment powered at +5V for 2 minutes, then 2 seconds to transmit data to the IHU and 2) maximum current 100 mA. Contact me at wa4sxm@amsat.org for additional details.

Jerry Zdenek demonstrated image capture and storage to an SD card. This data will be converted to the Robot-36 format and transmitted to earth on the 2 m FM downlink. The safety switches and circuits

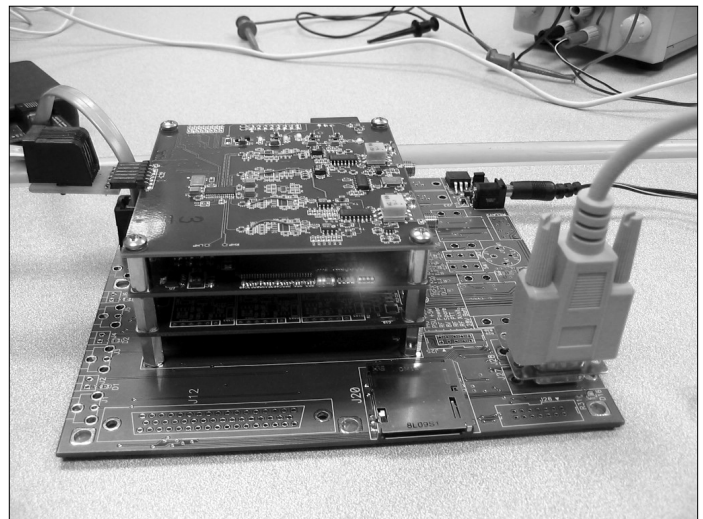


Photo 1: The IHU Stack.

were reviewed and documentation about the operation will be developed and sent for approval. Larry Brown brought the first 50-pin cable and it was connected and tested between the ICB and the safety switch box.

I am working on the SuitSat-2 information pages for the AMSAT Web site and expect to have some of them up by the time you receive this issue. The next meeting is planned for early April and I should have a great deal more information to report in the next issue of *The AMSAT Journal*. 🌐



Reach for the stars.

N3UC, formerly N4USI, control operator of AO-27, says, "AO-27 may be getting old and failing at times, after 15 years circling the earth. But, my IC-910H that I use to control AO-27, using data transmissions, has never failed me".

Icom 910H The perfect satellite rig.



Have fun communicating with these satellites using the IC-910H:

AO-27, SO-50, AO-51, and VO-52.

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